THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

ART. I.—*Sir William Jackson Hooker.*

SIR WILLIAM JACKSON HOOKER died at Kew, after a short illness, on the 12th of August last, in the eighty-first year of his age.

Seldom, if ever before, has the death of a botanist been so widely felt as a personal sorrow,—so extended were his relations, and so strongly did he attach to himself all who knew him. By the cultivators of botany in our own country, at least, this statement will not be thought exaggerated. Although few of our botanists ever had the privilege of personally knowing him, there are none who are not much indebted to him, either directly or indirectly. It is fitting, therefore, that some record of his life and tribute to his memory should appear upon the pages of the American Journal of Science.

The incidents of his life are soon told. He was born on the 6th of July, 1785, at Norwich, England, where his father,—who survived to even a greater age than his distinguished and only son,—was at that period confidential clerk in a large business establishment. He was descended from the same family with "the judicious Hooker," author of the "Ecclesiastical Polity." The name William Jackson was that of our botanist's cousin and godfather, who died young, and was soon followed by both his parents; in consequence of which their estate of Sea-salter, near Canterbury, came to young Hooker while yet a lad at the Norwich High School. He could therefore indulge the taste which he early developed for natural history, at this time mainly for ornithology. But the chance discovery of that

rare and curious Moss, *Buxbaumia aphylla*, which he took to his eminent townsman, Sir James Edward Smith, directed his attention to Botany, and fixed the bent of his long and active life. He now made extensive botanical tours through the wildest parts of Scotland, the Hebrides and the Orkneys, which his lithe and athletic frame and great activity fitted him keenly to enjoy. Coming up to London he made the acquaintance of Sir Joseph Banks and of the botanists he had drawn around him, Dryander, Solander, and Robert Brown.

In 1809 he went to Iceland, to explore that then little-known island. The exploration was most successful; but the ship in which he embarked with all his collections, notes, and drawings, was fired and destroyed and everything was lost, he himself narrowly escaping with his life. Hooker's earliest work, the Journal of a Tour in Iceland, in two octavo volumes, published at Yarmouth in 1811, and republished at London two years afterwards, gives an interesting account of his explorations and adventures, along with the history of a singular attempt at the time to revolutionize the island,—with which the disaster to the vessel he returned in was in some way connected, we forget how. Not disheartened by these losses, he now turned from a polar to an equatorial region, and made extensive preparations for going to Ceylon, with Sir Robert Brownrigg, then appointed Governor. But the disturbances which broke out in that island, more serious than those which attended the close of his Iceland tour, again frustrated his endeavors.

The strong disposition for travel and distant exploration, frustrated in his own case, came to fruit abundantly in the next generation, in the world-wide explorations of his son. He himself made no more distant journey than to Switzerland, Italy, and France, in 1814, becoming personally acquainted with the principal botanists of the day, and laying the foundations of his wide correspondence and great botanical collections. In 1815 he married the eldest daughter of the late Dawson Turner, of Yarmouth, and established his residence at Halesworth, in Suffolk. The next year, in 1816, besides publishing some of the *Musci* and *Hepaticæ* of Humboldt and Bonpland's collection, he brought to completion his first great botanical work, the British Jungermanniæ, with colored figures of each species, and microscopical analyses, in 84 plates, all from his own ready pencil,—a work which took rank as a model both for description and illustration. In 1828 he brought out, in conjunction with Dr. Taylor, the well-known Muscologia Britannica, the second edition of which, issued in 1827, is only recently superseded. The Musci Exotici, with 176 admirable plates, appeared, the first volume in 1818, the second in 1820. These were his principal works upon Mosses and the like,—an excellent subject for the training of a

botanist, and one in which Hooker, with quick eye, skilled hand, and intuitive judgment, was not only to excel but to lay the foundation of high excellence in general descriptive botany.

When arranging for a prolonged visit to Ceylon, it appears that he sold his landed property, and that his investment of the proceeds was unfortunate; so that the demands of an increasing family and of his enlarging collections, for which he always lavishly provided, made it needful for him to seek some remunerative scientific employment. Botanical instruction in Great Britain was then, more than now, nearly restricted to medical classes; the botanical chairs in the universities therefore mainly belonged to the medical faculty, and were filled by members of the profession. But, through the influence of Sir Joseph Banks, as is understood, the Regius Professorship of Botany in the University of Glasgow was offered to Hooker, and was accepted by him. He removed to Glasgow in the year 1820, and assumed the duties of this position. Here, for twenty years—the most productive years of his life—he was not only the most active and conspicuous working botanist of his country and time, but one of the best and most zealous of teachers. The fixed salary was then only fifty pounds; and the class-fees at first scarcely exceeded that sum. But his lecture-room was soon thronged with ardent and attached pupils, and the emoluments rose to a considerable sum, enabling him to build up his unrivalled herbarium, to patronize explorers and collectors in almost every accessible region, and to carry on his numerous expensive publications, very few of which could be at all remunerative.

The first production of these busy years was the Flora Scotica, brought out in 1821. The next year but one brought the first of the three volumes of the Exotic Flora, containing figures and descriptions of new, rare, or otherwise interesting exotic plants, admirably delineated, chiefly from those cultivated in the Glasgow and Edinburgh Botanic Gardens. Here first is manifested the interest in the flora of our own country, which has since identified the name of Hooker with North American botany,—a considerable number of our choicest plants, especially of the Orchis family, having been here illustrated by his pencil.

The Icones Filicum (in which he was associated with Dr. Greville,) in two large folio volumes, with 240 plates, begun in 1829 and finished in 1831, was his introduction to the great family of Ferns, to which he in later years devoted his chief attention.

In 1830 began, with the Botanical Miscellany, that series of periodical publications, which, continued for almost thirty years, stimulated the activity and facilitated the intercourse of botanists in no ordinary degree. The Miscellany, in royal octavo, with many plates, closed with its third volume, in 1833. The Journal of Botany, a continuation of the Miscellany in a cheaper

form, (in ordinary 8vo, issued monthly) took its place in 1834, but was itself superseded during the years 1835 and 1836 by the Companion to the Botanical Magazine (2 vols, imp. 8vo). In 1840 (after an interval in which the editor took charge of the botanical portion of Taylor's Annals of Natural History), the Journal was resumed and carried on to the fourth volume in 1842. Then, changed in title and enlarged, it appeared as the London Journal of Botany for seven years, until 1848, and finally, as the Journal of Botany and Kew Garden Miscellany, for nine years more, or to the close of 1857. The whole was carried on entirely at the editor's cost, he furnishing the MSS. for the letter-press, the drawings, &c., without charge, "so that it may be supposed his expenses were heavy, while his profits were, as he always anticipated, literally *nil*."

The plates of the Journal being too few to contain a tithe of the species in his herbarium which it was desirable to figure, an outlet for these was made by the Icones Plantarum, or Figures, with brief descriptive Characters and Remarks of New or Rare Plants, selected from the Author's Herbarium. Ten volumes of this work were published, with a thousand plates (in octavo), at the author's sole expense, and with no remuneration, between the years 1837 and 1854, the drawings of the earlier volumes by his own hand, of the later, by Mr. Fitch, whom he had trained to the work.

Botanists do not need to be told how rich these journals are in materials illustrative of North American Botany, containing as they do accounts of collections made by Scouler, Drummond, Douglas, Geyer, &c. Equally important for the botany of our western coast, especially of California, is the Botany of Capt. Beechey's Voyage (4to), in the elaboration of which Sir William Hooker was associated with Professor Walker-Arnott. But his greatest contribution to North American Botany—for which our lasting gratitude is due—was his Flora Boreali-Americana (2 vols, 4to, with 238 plates), of which the first part was issued in 1833, the last in 1840. Although denominated "the Botany of the northern parts of British America," it embraced the whole continent from Canada and Newfoundland, and on the Pacific from the borders of California, northward to the Arctic sea. Collections made in the British Arctic voyages had early come into his hands, as afterwards did all those made in the northern land expeditions by the late Sir John Richardson, Drummond, &c., and the great western collections of Douglas, Scouler, Tolmie, and others, while his devoted correspondents in the United States contributed everything they could furnish from this region. So that this work marks an epoch in North American Botany, which now could be treated as a whole.

We should not neglect to notice that, from the year 1827 down

to his death, he conducted that vast repertory of figures of the ornamental plants cultivated in Great Britain, the Botanical Magazine (contributing over 2,500 plates and descriptions); a work always as important to the botanist as to the cultivator, and under his editorship essential to both.

For the use of students at home, in 1830 he produced the British Flora, which ran through five or six editions before it was consigned to his successor in the chair at Glasgow, Prof. Arnott, who has edited two or three more.

We have enumerated the principal works published before he returned to England, including those which were re-edited or (as the periodicals) continued later. After twenty years' service in the Scotch University, Dr., now Sir William Hooker, K. H. (for in 1836 he accepted from William IV,—the last British sovereign who could bestow it,—the honor of Knight of the Hanoverian Order), was appointed by government to take the direction of the Royal Gardens at Kew, until then in the private occupation of the crown, but now to be developed into a national scientific establishment.

Ever since the death of Banks and Dryander, and while Aiton, the director, grew old and lost any scientific ambition he may once have had, Kew Gardens had declined in botanical importance. The little they preserved, indeed, was chiefly owing to the scientific spirit and unaided exertions of Mr. John Smith, then a foreman, afterwards for many years the superintending gardener (and well known to botanists for his writings upon Ferns), who, retired from his labors, still survives to rejoice in the changed scene.

The idea of converting Kew Gardens into a great national botanical establishment is thought to have originated either with Sir William Hooker himself, or with his powerful friend, and excellent patron of botany and horticulture, John, Duke of Bedford, the father of the present British Premier. Lord John Russell was in the ministry under Lord Melbourne when this project was pressed upon the authorities, and recommended to Parliament by the report of a scientific commission, and, succeeding to the Premiership,[1] he had the honor of carrying it into execution at the propitious moment, and in the year 1841, of appointing Sir William Hooker to the direction of the new establishment. The choice could hardly have been different, even without such influential political support; indeed his patron and friend, the Duke of Bedford, died two years before the appointment was made; but Hooker's special fitness for the place was manifest, and his claims were heartily seconded by the only

[1] We follow the article in the Gardeners' Chronicle in this statement. But we have an impression that Lord John Russell was not at the head of a Ministry until the year 1846.

other botanist who could have come into competition with him in this respect.[2] The office, moreover, was no pecuniary prize; the salary being only three hundred pounds a year (less, we believe, than the retiring pension of his unscientific superannuated predecessor), "with two hundred pounds to enable him to rent such a house as should accommodate his herbarium and library, by this time of immense extent, and essential, we need not say, to the working of the establishment, whether in a scientific or economic point of view." The salary, if we mistake not, has since been increased in some moderate proportion to the enlarged responsibilities and cares of the vast concern; but, up to his death, so important an auxiliary as his unrivalled herbarium, and the greatest scientific attraction of the institution, was left to be supported (excepting some incidental aid) out of the Director's own private means.

Such record as need here be made of Sir William Hooker as Director of Kew Gardens can be best and most briefly given mainly in the words of a writer in the Gardener's Chronicle (for Sept. 2), to whose ripe judgment and experience we may defer.

"Sir William entered upon his duties in command of unusual resources for the development of the gardens, such as had never been combined in any other person. Single in purpose and straight-forward in action, enthusiastic in manner, and at the same time prepared to advance by degrees, he at once won the confidence of that branch of the government under which he worked..... To those in office above him, he imparted much of the zeal and interest he himself felt, which was proved by constant visits to the gardens, resulting in invariable approval of what he was doing, and promises of aid for the future. Another means at his disposal, and which he at once brought to

[2] We refer of course to Dr. Lindley; and now while revising the proof of this article, the sad intelligence reaches us that he also is no more; that this eminent botanist and remarkable man died, of apoplexy, on the first of November, at the age of sixty-six.

It is well known that Dr. Lindley's health became seriously impaired a year or two ago, and that his scientific pursuits had to be given up, with slight hope that they could ever be renewed. We were under the impression, however,—perhaps an erroneous one,—that he was the author of the well-written biographical notice of Sir William Hooker which appeared in the Gardeners' Chronicle, and from which the citations in our article were taken; and on this we had founded a hope that his vigor was returning, and that his usefulness might still be prolonged. A sketch of his life and scientific labors may hereafter be given. But we may now properly and freely speak, as we had wished to do in this article, of the paramount influence which the two eminent botanists, now taken from us, have exerted upon the condition of the science they cultivated in their own country. From forty years ago down to recent times, although neither was the most profound botanist of his age, both were unrivalled for the example they set and the active interest they took in diffusing a knowledge of Botany in Great Britain, and promoting its study generally, for which they deserve the large and lasting gratitude of their countrymen. One other name will suggest itself as worthy to be associated with theirs in this regard; but we trust the day is very distant in which that may be added to an obituary record.

bear on the work in hand, was his extensive foreign and colonial correspondence, including especially that with a large number of students whom he had imbued with a love of botany, and who were scattered over the most remote countries of the globe, and several of whom, indeed, remained in more or less active correspondence with the Gardens up to the day of his death. His views were further greatly facilitated by his friendly intercourse with the Foreign and Colonial offices, the Admirality, and the East India Company, to all of whom he had been the means of rendering services, by the recommendation of former pupils to posts in their employment, and by publishing the botanical results of the expeditions they sent out.....

"At the time of Sir William's taking office, the Gardens consisted of eleven acres, with a most imperfect and generally dilapidated series of ten hot houses and conservatories. Most of these have since been gradually pulled down; and, with the exception of the great orangery (now used as a museum for woods) and the large architectural house near the garden gates, which had just previously been removed from Buckingham Palace, not one now remains. They have been replaced by twenty-five structures (in most cases of much larger dimensions) exclusive of the Palm-stove and the hitherto unfinished great conservatory in the pleasure grounds.

"To describe the various improvements which have resulted in the present establishment,—including, as it does, a botanic garden of 75 acres, a pleasure-ground or arboretum of 270 acres, three museums, stored with many thousand specimens of vegetable products, and a magnificent library and herbarium, the finest in Europe, placed in the late King of Hanover's house on one side of Kew Green and adjoining the gardens, — would rather be to give a history of the gardens than the life of their Director."....

"It might be supposed that the twenty-four years of Sir William's life spent at Kew in the above public improvements, added to the daily correspondence and superintendence of the Gardens, would have left little time and energy for scientific pursuits. Such, however, was far from being the case. By keeping up the active habits of his early life, he was enabled to get through a greater amount of scientific work than any other botanist of his age."

From this period his contributions to systematic botany, if we except the journals and illustrated works (continued until lately, and some of them to the last), were mainly restricted to his old favorites the Ferns. Some years before he removed to Kew, he found the veteran Francis Bauer, then an octogenarian, or near it, employed in drawing under the microscope admirable and faithful illustrations of the fructification of Ferns. He ar-

ranged immediately for their publication, drew up the letter-press, and so brought out, between 1838 and 1842, the well-known work entitled "Genera Filicum, or Illustrations of the Ferns and other allied Genera." His large quarto, "Filices Exoticæ, in Colored Figures and Descriptions of Exotic Ferns, chiefly of such as are cultivated in the Royal Gardens of Kew," (100 plates) appeared in 1859;—the drawings of these, as of nearly all his illustrated works for the last thirty years, by Walter Fitch, his indefatigable coadjutor, whom he had trained in Scotland, and who soon became "the most distinguished botanical artist in Europe." "A second Century of Ferns" (imp. 8vo,) was published in 1860 and 1861, the First Century being the tenth and closing volume of the Icones Plantarum.

But the principal systematic work of these later years was his "Species Filicum, being Descriptions of the known Ferns, ... accompanied with numerous figures," in 5 volumes, 8vo. The first volume of this work appeared in 1846, the last only a year and a half ago.

The crowd of new Ferns and new knowledge which had accumulated in the interval of seventeen or eighteen years, demanded large revision and augmentation of the earlier volumes to bring them up to the level of the later ones. Moreover, a compendious work on this favorite class of plants was much needed. Both objects might be well accomplished by a synopsis of known Ferns in a single volume, to be for our day what Swartz's Synopsis Filicum was just sixty years ago. To this Sir William Hooker, upon the verge of fourscore, undauntedly turned, as soon as the last sheets of the Species Filicum passed from his hands, devoting to it the time that remained after attending to his administrative duties. Upon it he steadily labored, with unabated zeal and with powers almost unimpaired, conscientiously diligent and constitutionally buoyant to the last. He had made no small progress in the work, and had carried the sheets of the initial number through the press, when an attack of diptheria, then epidemic at Kew, suddenly closed his long, honored, and most useful life.

Our survey of what Sir Wm. Hooker did for science would be incomplete indeed, if it were confined to his published works —numerous and important as they are—and to the wise and efficient administration through which, in the short space of twenty-four years, a Queen's flower and kitchen garden and pleasure-grounds have been transformed into an imperial botanical establishment of unrivalled interest and value. Account should be taken of the spirit in which he worked, of the researches and explorations he promoted, of the aid and encouragement he extended to his fellow-laborers, especially to young and rising botanists, and of the means and appliances he gathered for their use no less than for his own.

The single-mindedness with which he gave himself to his scientific work, and the conscientiousness with which he lived *for* science while he lived *by* it, were above all praise. Eminently fitted to shine in society, remarkably good-looking, and of the most pleasing address, frank, cordial, and withal of a very genial disposition, he never dissipated his time and energies in the rounds of fashionable life, but ever avoided the social prominence and worldly distinctions which some sedulously seek. So that,—however it may or ought to be regarded in a country where court honors and government rewards have a factitious importance,—we count it a high compliment to his sense and modesty that no such distinctions were ever conferred upon him, in recognition of all that he accomplished at Kew.

Nor was there in him,—while standing in a position like that occupied by Banks and Smith in his early days,—the least manifestation of a tendency to overshadow the science with his own importance, or of indifference to its general advancement. Far from monopolizing even the choicest botanical materials which large expenditure of time and toil and money brought into his hands, he delighted in setting other botanists to work upon whatever portion they wished to elaborate; not only imparting freely, even to comparatively young and untried men of promise the multitude of specimens he could distribute, and giving to all comers full access to his whole herbarium, but sending portions of it to distant investigators, so long as this could be done without too great detriment or inconvenience. He not only watched for opportunities of attaching botanists to government expeditions and voyages, and secured the publication of their results, but also largely assisted many private collectors,—whose fullest sets are among the treasures of far the richest herbarium ever accumulated in one man's life-time, if not the amplest anywhere in existence.

One of the later and not least important services which Sir William Hooker has rendered to botany is the inauguration, through his recommendation and influence, of a plan for the publication, under government patronage, of the Floras of the the different British colonies and possessions, scattered over every part of the world. Some of these (that of Hongkong and that of the British West Indies) are already completed; others (like that of Australia, and the Cape Flora of Harvey and Sonder, adopted into the series,) are in course of publication; and still others are ready to be commenced.

The free and cordial way in which Hooker worked in conjunction with others is partly seen in the various names which are associated with his in authorship. This came in part from the wide range of subjects over which his survey extended,—a range

which must have contributed much to the breadth of his views and the sureness of his judgment. Invaluable as such extent of study is, in the present state and prospects of our science we can hardly expect to see again a botanist so widely and so well acquainted both with cryptogamic and phanerogamic botany, or one capable of doing so much for the advancement and illustration of both.

Our narrative of Sir William Hooker's scientific career and our estimate of his influence has, we trust, clearly, though incidentally, informed our readers what manner of man he was. To the wide circle of botanists, in which he has long filled so conspicuous a place, to his surviving American friends and correspondents, some of whom have known him long and well,—and "none knew him but to love him, nor named him but to praise,"—it is superfluous to say that Sir William Hooker was one of the most admirable of men, a model Christian Gentleman.

There could really be no question as to the succession to the charge of the great botanical establishment at Kew. But we may add, for the information of many of our readers, that the directorship vacated by Sir William's death has been filled by the appointment of his only surviving son, Dr. Joseph Dalton Hooker, whose well-established scientific fame and ability, no less than his lineage, may assure the continued equally successful administration of this most interesting and important trust.

A. G.

ART. II.—*On a Boulder, and Glacial Scratches, at Englewood, N. J.;* by Rev. W. B. DWIGHT.

THE summit-level of the trap ridge known as the Palisades, in Bergen Co., N. J., presents in many places an appearance suggestive of glacial erosion; but on account of the ease with which the trap disintegrates, whether exposed to the air, or to a covering of moist earth, it has heretofore been difficult to find a surface where the polishing and grooving are sufficiently plain to warrant a decisive conclusion. Such a locality has however been recently observed.

A large boulder, called "Sampson's Rock," at Englewood, N. J., has long been an object of interest among the residents of the place for its isolation and bold and striking appearance, but it was not known to possess any special scientific interest, until the year 1860; in that year, in company with my brother, I visited the place, and we soon discovered that this imposing boulder preserves beneath its concave base a record of the great movement which placed it there.

The locality is situated on the top of the Palisades, about 100 rods from the brow of the precipice that faces the Hudson river, and about 450 feet above the level of the river. It is on the premises of Francis Howland, Esq., fifty rods to the rear of the residence of Mr. Wm. B. Dana; and as its proprietor is a man of much public spirit, we may feel assured that it will be carefully preserved. The monument with its inscriptions has a vastly greater antiquity than those of Assyria or Egypt.

The boulder rests upon the trap rock. It consists of coarse red sandstone, and is from the triassico-jurassic formation which the trap-dike of the Palisades intersects. This sandstone is the surface rock for a large extent of country to the west and north. In the latter direction it extends thirty miles to Stony Point, and this is therefore about the extreme distance which, judging from the present limits of the formation, can be assigned for the passage of the boulder.

The general level of the sandstone in the vicinity is from one to two hundred feet below the summit of the trap, and none of the sandstone is in position within a mile and a half of the locality.

The boulder averages ten feet long by seven broad, and is nine feet in greatest height. The weight computed from careful measurement is about thirty-two tons. It is nearly a square block below but terminates in a low pyramid above. Its under surface is quite concave and it rests upon three points; it has thus shielded the record of erosion beneath.

The area covered by the block is undulating in surface, and throughout is smoothed and strongly marked with parallel groovings and scratches. The course of the scratches is mainly S. 34° E. (true); a few run 5° to 10° more to the east.

The area thus protected slopes gradually away on the north and east; but to the west and south it descends perpendicularly 34 to 42 inches down to the general level; and this appears to give a measure of the loss which the rock has experienced since the glacial period, either by slow superficial disintegration, or by a cleavage into vertical columns and a subsequent falling away of the masses.

The courses of the scratches correspond nearly to courses observed by Ramsay upon the Catskill mountain, S. 22° E., as also to observations of Mather on New York island bearing S. 25°, 35°, and 45° E. We are thus led clearly to the conclusion that this boulder was located, and these groovings scored, by the great Hudson-valley glacier which has left so many other records of its passage. In this instance, an interesting page of the natural history of New Jersey, has been preserved by this natural cover from the disintegrating elements and from the equally decomposing action of moist soil.

Englewood, N. J., Oct. 26, 1865.

ART. III.—*On a Subsidence of land at Coxsackie, N. Y.;* by Rev. W. B. DWIGHT.

LANDSLIDES upon a small scale are quite frequent in the soft or semi-consolidated Post-tertiary clays of the Hudson river and its tributaries. In the great majority of cases, however, they do not, either in extent, or in any of the attendant phenomena, depart from the simple, typical, slide-movement.

An occurrence of this kind having come under my observation in 1863, (and in a subsequent visit to the locality in 1864,) which is of remarkable extent, and which combines, besides many other interesting features, the double effect of depression and of elevation, I think it desirable to put an account of it upon record.

The locality is upon the farm of Mr. Casper Flansburgh, four miles north of the village of Coxsackie, N. Y., and two miles west of the Hudson river.[1] The Post-tertiary terrace has here a width of about three miles, having its extreme western limit at the base of a bold ridge of Helderberg limestones, from which line its surface continues quite level and unbroken toward the east, till, at the distance of one mile from the hills, it reaches the ravine which is the scene of this movement. Here a creek has excavated a ravine or valley of a considerable size, cutting through the terrace, which stands at the same level on both sides of the valley. The banks thus formed are by no means steep, but gradual declivities; the terrace level was about 75 feet above the bed of the creek previous to the disturbance. The general course of the creek and valley at this point is N. 45° E; but a little below, and just at the termination of the slide, the course is north; the stream was eight feet wide, and six feet deep.

The terrace consists superficially of light-colored clay soil, mixed with sand and stones. Underneath this there is a thick stratum of light gray clay, quite firmly consolidated into well-defined horizontal laminæ of rock, very soft and porous, very fine, and free from grit, but containing a considerable amount of lime. These consolidated laminæ do not appear except where there has been a recent excavation, as exposure soon destroys their structure; about fifty feet of these layers could be made out at the fracture of the slide; how much greater their depth, I was not able to ascertain. Below these light-colored layers is a deposit of blue clay, everywhere quite distinct from the other, as stated by the New York State Reports: "these clays are almost uniformly associated; the blue lying below the other; the line

[1] I acknowledge, with pleasure, my indebtedness to Mr. Casper Flansburgh, the owner of the property upon which the subsidence took place, for his cordial assistance, and to Mr. H. A. Whitbeck of Coxsackie, for much useful information founded upon his own intelligent observations, and also for valuable sketches of the locality.

of junction is very distinctly marked." (N. Y. State Geol. Rep. 1st Dist., p. 128.) This blue clay is also of very fine quality, and valuable for pottery: it contains more lime than the other, effervescing freely with acids. There is no appearance in this blue clay of consolidation into compact laminæ, but there is evidence that it is brought into a semi-liquid condition by the presence of water much more easily and thoroughly than the gray clay above. In the normal condition of the valley, the blue clay was not visible, being covered, even at the lowest points, by its lighter-colored associate.

The terrace-level is cleared and tilled; the whole of the slope of the valley or ravine is, however, timbered with forest trees.

On the morning of March 16th, 1861, Mr. Flansburgh, on visiting this part of his farm, to his utter amazement found his geography of the locality entirely at fault; a precipice, and a yawning gulf took the place of his wooded hill-slope; his sloping ground was nearly level, and his level sloping; a grove of fine trees stood waist-deep in a new pond of water, while the bed of his creek stood aloft high and dry; his trees were pointing in every imaginable direction, looking as if they had passed a hard night.

The movement took place between 5 P. M., of the 15th, and 9 A. M., of the 16th. There is no evidence that it attracted the attention of any one at the time, which is not very strange, as the nearest house is a half a mile distant. From the appearances at the time of visiting the locality, I was not able to form any judgment concerning the amount of local erosion on the edge of the bank at the creek, but am informed that there was a perceptible, though not extensive, undermining. There was no frost in the ground, but it was covered with one foot of very dense snow, which was coated with a heavy crust.

The mass of earth consisting of the slope of the west bank and a part of the summit level, broke off sharply and perpendicularly across the top of the bank about 30 or 40 feet back from the brow; the line of fracture then curved to the east on both sides until it touched the creek, after enclosing a semi-circular tract of about 6½ acres. The flexure seems to have been determined by small ravines running toward the creek at right angles to its course.

The fragment, which was in fact an enormous wedge of earth, 75 feet thick at the back, being now free, was at once subjected to two different forces; for it was immediately separated into two parts by a chasm opening lengthwise and stretching from end to end, (N. and S.), at the distance from the upper edge, of about one-third of the whole width of the detached mass. The portion west of this line, consisting of the brow of the hill, and

the higher part of the slope, at once sunk, partially throughout its whole extent, but most deeply at its western edge, which rested at a depth of 40 feet below its former position at the terrace level; it probably moved also a few feet to the eastward.

The other fragment also sunk considerably at its thicker end, thus bringing its surface nearer to a level; but it had also a decided sliding movement toward the creek, for the distance of from a foot or two at the southern, to 42 feet at the northern end. This measurement was obtained by ascertaining the variation of a line of stakes, trees and other landmarks, from the original line which was known.

The effect of this double movement upon the ground at the creek was extraordinary; the whole bed of the stream, together with a portion of its borders, was lifted bodily, and left at the top of a long and nearly continuous mound. This mound is from 75 to 150 feet wide at the base, and in most places 30 feet high, thus becoming the highest ground on the eastern section of the slide.

At the same time heavy masses of the underlying blue clay were forced up at the outer (eastern) edge of the mound, and, pouring over the adjacent clay of lighter color, now lies in beds in reverse of its geological position, forming a striking feature of the scene. The water-course being thus blocked up, a large pond was formed to the south, submerging a grove of trees in fifteen or twenty feet of water. Another pond was formed along the western side of the mound, and smaller ones in various positions. The creek has since formed a new channel east of the mound at a much higher level than before.

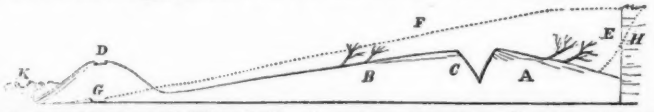
The surface of the mound is much fissured; its trees are tilted, and in many places uprooted from beneath; on the main slope, west of the mound is a tract of about $2\frac{1}{2}$ acres of quite unbroken ground, the only sign of change being the uniform slant of the trees; but at the northern and southern extremities, especially at the northern—there are numerous intersecting fissures, varying from one to ten feet in width, and the same in depth; making the surface to resemble the irregular fragments of a floe of ice left by the tide upon a sloping shore. The positions of the trees are correspondingly irregular. In one instance a fissure one foot in width, opened directly under the roots of a tall maple, splitting its trunk to the height of fifteen feet; one margin of the fissure then slipped past the other nine or ten feet, carrying with it its half of the trunk, twisting the tree and holding it in a sufficiently awkward position.

In forming a correct conclusion as to the nature and direction of the forces which produced this movement, it must be noticed, that the *blue clay* underneath was capable of assuming a condition approaching fluidity, and its appearance as found both in

the front and rear of the area of subsidence, proves it to have been in this condition; on the other hand, the lighter-colored clay above, though softened by water so as to be quite flexible, and capable of parting in any one line of great pressure, yet possessed, in its consolidation into distinct laminæ, and in its being interpenetrated by the roots of trees and underbrush, elements of tenacity,—which enabled it to act as an organized mass, which quality was entirely wanting in the under-clay.

There was then a tongue of land of considerable tenacity, a few feet thick at the lower end, and seventy-five at the upper, resting upon a very mobile and smooth clay: the erosion of a shallow channel at the creek, afforded a passage for the *exit* of this clay; and the great and principal force which caused the fracture, was in my judgment, one acting in a *perpendicular* direction, as shown from the fact, 1st, that the fracture is a sharp, perpendicular well defined line, and not the ragged, irregular sloping line usually seen where the soil has been simply drawn down a declivity; 2nd, that immediately after the fracture, the thickest and heaviest portion *did sink* and forced the blue clay before it, outward, and upward, at the lower levels; its own lateral motion being very small.

The following section will further illustrate the action:



Cross section from N. W. to S. E. A, western fragment. B, eastern do. C, chasm. D, new mound, with the bed of the creek at its summit, (30 feet.) E, perpendicular line of fracture. F, former outline of the bank. G, former position of the creek. H, present appearance of the line of fracture. K, masses of blue clay forced up from below, and containing the present bed of the creek.

The eastern fragment, in addition to sinking considerably, slid forty-two feet toward the creek; impelled however in this lateral direction it would seem, not by the principal force, but by a secondary and incidental one, for it did not overwhelm the hollow of the creek, nor did it effect a single *fold* over toward the east, but allowed its lower edge, with the bed of the stream, to be raised by the clay, extended by the subsiding portions, into a mound of equal slope on both sides.

The whole movement appears therefore to be best explained upon the supposition of a body *floating* upon a semi-liquid, and seeking to right itself from a position of very unstable equilibrium; it resembles in many respects the interesting subsidence which occurred at Tivoli on the Hudson in April, 1862.

Although many changes have since taken place in its superficial appearance, much yet remains that is characteristic and wonderful—enough to repay amply the trouble of a visit.

Englewood, N. J., Nov. 11th, 1865.

Art. IV.—*On the Crystalline Nature of Glass;* by Charles M. Wetherill, Ph.D., M.D.[1]

The usual explanation given for the different appearance of etchings by hydrofluoric acid in the gaseous and in the liquid state, is that by employing gas, the products of decomposition of the glass remain in the corroded cavities communicating a ground-glass appearance. This does not obtain by the use of the liquid acid, since in this case the said products are removed from the cavities.

An examination of this subject by the aid of the microscope at once showed that the ordinary explanation is erroneous. Ground glass is seen, under the microscope, to be covered with irregular cavities of uniform size, which act by the dispersion of light to produce the characteristic appearance of glass in this condition.

When glass is exposed to the vapor of hydrofluoric acid, the corrodent is deposited in the condition of minute globules, each of which attacks the surface to which it is attached. Articles of glass placed near the apparatus in which the gas is generated are thus coated with a delicate film of the vapor, and are etched, so that the microscope exhibits extremely minute and shallow cavities in which, after cleansing the surface by water, no trace of other substance than glass is perceptible. When the exposure to the acid fumes is more prolonged, the cavities are deeper and more irregular. A still greater irregularity is effected by a more lengthened action of the corrosive vapor; the acid acts more intensely upon the spots first attacked, and the holes are extended with ragged margins and deepened by the action.

On the other hand, when the glass is immersed in *liquid* hydrofluoric acid, or if a drop of the same be suffered to fall upon the plate, the whole surface is corroded with a certain degree of uniformity. There are no minute points of action as in the case of the deposition of spherules of the acid vapor.

Hydrofluoric acid gas, so called, is thus shown to be a *vapor*, constituted of minute drops, like cloud. It would be interesting to test the effect upon glass of the perfectly anhydrous gas obtained lately. From these considerations, hydrofluoric gas appears to possess in an eminent degree the cloud-forming property of antozone. An appreciable quantity of this substance exists in the Woelsendorf fluor spar, and it may be questioned whether all specimens of this mineral do not contain traces of antozone.

In observing the specimens etched by the liquid acid, the crystalline nature of glass was discovered and witnessed in every

[1] The observations of which an account is here given were made in the laboratory of the Smithsonian Institute, Washington.

case. By an examination of the literature of the subject it was ascertained that Leydolt (Wiener Acad. Bericht, viii, 261) had made this interesting and important discovery. I have been inclined to publish my results because Leydolt's observations do not appear to have received the attention which they merit; because my manner of applying the acid is different; and because crystals were observed of form differing from those described in Leydolt's paper.

In addition to these reasons, his discovery may appear to need a certain confirmation, since Daubrée has asserted (Comptes Rend., xlv, 792) that the crystalline phenomena are due not to the glass, but to the deposition of crystals of fluosilicid of potassium, &c., which retard the corrosive action by protecting the glass under them. In the following experiments with as prolonged a microscopic observation as the object-glass could be trusted to the corrosive fumes, the result of the reaction of a drop of the acid upon the glass appeared to be amorphous. In an experiment in which a watch glass was exposed, with the convex surface downward, as a cover to a platinum crucible containing hydrofluoric acid, a lapse of twelve hours effected a deep corrosion. This was most extensive at the lowest point of the glass where a large drop of liquid was adhering. The solid products of the reaction had settled to the inferior portion of the drop, and some of them had fallen with previous drops into the crucible. A microscopic examination of the glass demonstrated the presence of etched crystals, which could not, under the circumstances, have resulted from a protecting effect of crystals of fluosilicid.

Frankenheim (Jr. pr. Ch., liv, 430) maintains that solid bodies generated from a liquid are always crystalline, although the crystals may be too minute to be perceptible by our present instruments. His arguments, in the cases of glass, resins and the like, are *a priori*, being based upon the analogies proceeding from a study of the general properties of matter. They render the crystalline character of glass very probable.

This chemist places the glasses, resins, and fats in the same category in their relations to crystallization. In the transition of these bodies to liquids by an elevation of temperature, they pass through conditions of softness and semi-fluidity before melting. This softening does not depend upon a malleability, as in the case of metals. Glass, for example, remains perfectly brittle to a certain temperature, and when fusion begins to take place the angles are rounded by the cohesion of the liquid portions and the adhesion of these to the parts not yet melted. At a higher temperature, the liquid portion constitutes the mass of the body, but in it are suspended innumerable solid particles, which communicate to it a sticky or gelatinous character.

When melted glass cools, its least fusible compounds separate at first, and when the refrigeration is gradual a distinct crystallization takes place. By a rapid cooling the crystals must be more numerous and much smaller. If they cannot be detected in such glass by the eye or by aid of the microscope, the reason may be in their extreme tenuity, so that the light behaves to them as to the natural roughness of the polished surface. The author observes that silica is often separated in so fine a condition that it passes through the small pores of the filter. He finds no reason in the phenomena of this class of bodies for an actual amorphism; but assumes that they are composed of *crystals*, which, although really small, are large in relation to the atomic molecules of the bodies.

He concludes (op. cit., p. 476) that "amorphous bodies, in the ordinary sense of the expression, are unknown among solids, for solidity depends upon crystallization."

Gaudin, in his *brochure* (*Reforme de la Chemie Minerale et Organique*, Paris. 1863), endeavors to show what crystalline forms are probable for all bodies, deducing his results from the number of atoms in their chemical formulæ and the simplest manner in which they may be arranged. Chemists are divided as to the reliance to be placed upon Gaudin's views; but if they are tenable, or if in any degree founded upon reasonable grounds, the crystalline condition of all solid bodies would seem to be a necessary consequence.

Pelouze (Comptes Rendus, xl, 1321), in an investigation of the devitrefication of glass, as in the so-called porcelain of Réaumur, exposed a tablet of plate glass to incipient fusion upon the sole of a glass furnace for a period of 24–48 hours, and then suffered it to cool slowly. The result was a porcelain-like substance consisting of numerous opaque acicular crystals which were arranged in parallel series, the individuals being perpendicular to the surface of the plate. It was found that the crystallization proceeded from the surface to the interior of the tablet, and that when the process was arrested there was a distinct line of demarcation between the crystalline and vitreous portions. In rare instances the fibrous structure was wanting, and the crystallization was of such nature that the fractured glass presented the appearance of fine white marble. Occasionally the crystals were replaced by an enamel-like material. In repeated experiments of this character Pelouze found that the glass experienced no change of weight during the devitrefication, and the altered glass was restored to its transparency by a simple fusion. The process might be repeated several times without any alteration of weight. Devitrefied window glass, and more especially bottle glass when in large masses in the melting pots, sometimes exhibited yellowish-green *needles*, which were occasionally *small* and

short, but often exceeded a centimeter in length, being closely adherent one to another and *interwoven in all directions*. The vacant spaces between the crystals recalled the crystallization of sulphur.

The crystallization of the glass was assisted by the addition of infusible or difficultly fusible substances to it when in the pasty condition. This is shown by the following experiment performed upon portions of material weighing one hundred kilograms.

Two melting pots were half filled with the same kind of glass, which was at first melted and then suffered to cool until it had assumed a pasty or tenacious consistence. To one crucible a small quantity of vitreous matter was added, and both pots were suffered to cool. That to which nothing had been added contained a transparent glassy mass, while the material in the other crucible was nearly opaque from crystal aggregations. One per cent of sand added to the pasty glass produced the same effect; and when quartz was employed the mineral retained its transparency, remaining mingled with the devitrefied mass.

Pelouze found that mirror, plate, lead, bottle, and Bohemian glasses were all susceptible of devitrefication, although with different degrees of readiness, the tri-silicate of soda being the most ready. A glass of silica, boracic acid, potassa and zinc yielded mere traces of crystallization; but the combination of silica and boracic acid with potassa and lime could not be devitrefied by an exposure of ninety-six hours to a temperature at which softening took place.

This chemist infers that the change experienced by glass during this process is a physical, and not a chemical one. He states, as the result of many analyses performed by himself, that the crystals do not differ in composition from the vitreous mass in which they are embedded.

Dumas (op. cit.) takes exceptions to some of Pelouze's inferences, having found a difference in the constitution of the glassy and crystallized portions of the mass. Thus, in respect to silica; for the vitreous portion 64·7 per cent, and in the crystals 68·2.

Leblanc found in the two kinds respectively: for mirror glass 66·2 and 69·3; for bottle glass 57·9 and 62·95. In the bottle glass Leblanc found that the transparent portions contained 1·57 per cent of protoxyd of iron, although only indistinct traces of this base were detected in the opaque part.

Dumas therefore holds that the products obtained by Pelouze are "analogous to *mixtures of the fatty acids*, which by fusion form a homogeneous liquid, which by cooling gives a fibrous solid, in which although the eye can perceive nothing heterogeneous, each acid has separated in its own crystal form."

Terreil (Comptes Rendus, xlv, 693) observed in the melting pots of a glass furnace which had cooled very slowly, a perfectly

crystalline mass which contained cavities with small transparent crystals. These had a composition similar to that of a transparent bottle glass prepared from the same materials in the same proportions. Thus:

	Glass crystals.	Bottle glass.
Silica,	55·85	56·84
Lime,	24·14	21·15
Magnesia,	7·63	6·37
Alumina,	2·22	3·64
Peroxyd iron,	1·06	2·59
Soda,	8·47	8·69
Potassa,	0·63	0·40
Manganese,	traces	traces
	100·00	99·68
Spec. gravity,	2·824	2·724

For the composition of a partially devitrefied glass which was formed in the same furnace, under different circumstances, he found:

	Vitreous part.	Devitrefied part.
Silica,	62·40	63·67
Lime,	18·14	18·65
Magnesia,	4·47	6·12
Alumina,	7·21	4·98
Peroxyd iron,	2·66	0·71
Alkalies,	5·12	5·87
Manganese,	traces	traces
	100·00	100·00
Spec. gravity,	2·610	2·857

Leydolt (Wien. Acad. Bericht, viii, 261) introduces his experiments upon glass etching by observations of himself and others upon specimens of glass and slag in which crystals are visible without the aid of hydrofluoric acid.

Thus Prechtl melted a considerable quantity of feldspar with one and a half cwt. of glass and cooled the mass in water. In the inside of the lump, where the refrigeration had been more gradual, were found numerous crystals of feldspar, with well defined angles and edges, one of the crystals having the volume of a cubic inch.

Among the specimens of glass with perceptible crystals illustrated by Leydolt are the following:

1. Green flint glass, perfectly transparent, containing opaque grains, which are resolved by the microscope into well defined octahedra of one-half a line in diameter.

2. A glass flux, of emerald color, containing many groups of four-sided prisms, of white tinge and pearly luster.

3. A large mass of blackish green glass, with prismatic crystals singly and in aggregations, also fibrous crystals in globular tufts. The color of the crystals is dirty yellow, passing into green; their luster pearly. They had a rhomboidal section, and were a line in length by one-eighth of a line in thickness.

4. A bluish green English glass, containing tufts of needles uniting to globules of one and a half lines in diameter.

5. A glass flux, of red and green color, containing a large quantity of small four-sided prisms, solitary, and in tufts. The prisms were transparent, and of the same color as the glass, so that they could only be distinguished by the different degree of their refraction and that of the matrix.

6. A vitreous iron slag, of bottle-green color, containing perfect cubes of whitish tinge and pearly luster; also feathery crystals.

7. Another specimen of iron ore slag, similar to the last; but in which the cubes are larger, of nearly the color of the glass, and more equally diffused through the mass.

In a similar slag the cubes were of olive-green color, and in another specimen the cubes were sparse and accompanied by feathery crystals. To these may be added the observations of Splitgerber (Pogg. Ann., lxxvi, 566), that in a lead glass slag presented to Faraday by H. Rose, he found large and well defined six-sided tablets. In a glass prepared with 100 silica, 40 soda, and 10 carbonate of lime, which were perfectly fused and suffered to cool slowly for six hours, he discovered fine acicular crystals grouped star-wise, like flakes of snow. These floated in quantity in the melted liquid, and disappeared when the temperature of the crucible was raised again.

Leydolt's experiments of etching were performed by placing slips of glass in a mixture of fluor spar and oil of vitriol; by exposing glass plates to an atmosphere of hydrofluoric acid vapor; or finally by employing a very dilute solution of this acid contained in leaden vessels.

The following are his results:

1. A thick tablet of fine colorless mirror plate glass, after exposure to the vapor, was covered with colorless rhomboidal crystals. They projected from the plate, were perceptible to the touch, and plainly visible to the naked eye, from the contrast between their lustrous surfaces and the rough etched background.

He obtained similar forms by fluor spar and oil of vitriol, and also by the use of the dilute acid. He infers that they are not quartz, which does not dissolve in hydrofluoric acid, but that they are of similar nature to that of their matrix.

2. A flint glass of bluish color, passing into violet, transparent, and apparently homogeneous, yielded crystals by careful etching. Ordinary window glass gave similar crystals which were of the form of rectangular tablets.

3. A pure transparent English glass (a salt cellar), various vessels of French and Bohemian ware, very thick glass stoppers, glass of various colors, such as white bluish or green, and differently tinted glass fluxes and plates, all yielded similar crystals.

4. Some of the dilute residue of the reaction of sulphuric acid upon fluor spar having been left in a beaker glass, etched the same, with beautiful tufts of fibrous crystals, giving the appearance of some specimens of agate.

Leydolt infers from his experiments that all glass consists of an amorphous mass containing a variable proportion of crystals, and consequently; that not only density and composition, but also the more or less uniform distribution of the crystals, and their nature have a marked influence upon the character and optical behavior of the glass.

He deems the following questions to be of importance.

1. Upon what circumstances depends the formation of the crystals in relation to quantity?

2. What influence have the crystals upon optic phenomena?

3. May not their presence have an influence upon the doubly refracting character which glass acquires by heating and sudden cooling; or by pressure?

4. What substances may be dissolved in melted glass and separated therefrom by slow cooling?

Daubrée (C. R., xlv, 792) obtained various crystals by exposing glass for weeks to the action of water and steam in sealed iron vessels, at a temperature of 400° C. The glass was converted into a white, swollen, kaolin-like substance, composed almost entirely of crystalline particles. He found many crystals of quartz, and also acicular forms of nearly the same composition as Wollastonite (53 p. c. silica, 46 lime; with traces of magnesia). The quantity of water equalled half the weight of the glass, and the action of the water was the same as that of the steam.

Daubrée does not believe that the crystals preëxisted in the glass; but were formed by the action of the water. Although this is probable, it may be questioned whether some of the crystals were not ready formed in the glass.

My own experiments were performed by dropping strong liquid hydrofluoric acid upon plates of glass, using one or successive drops, according to the degree of etching desired. By this means the energy of the acid is expended upon one particular spot of the glass, and by taking more or less of the solvent, or by employing it of greater or less strength, the reaction is completely under control.

The acid was generated in the usual manner in a leaden retort with a condensing tube of the same metal, cooled with a mixture of salt and ice; the liquid acid was received in a platinum crucible, also refrigerated.

The following are the results of the experiments:

When the vapor escaping from the crucible was condensed upon plates of glass, a "ground glass" etching, with in some instances distinct traces of crystallization, resulted.

The following is the action of the liquid acid upon different kinds of glass.

1. Greenish window glass, free from lead. One drop of the acid acted energetically, coating the glass with a white sediment. When washed, the spot was found to be deeply etched, and presented a roughened although transparent appearance. Under the microscope, with oblique, transmitted light, the surface was found to be covered with a web of acicular crystals, crossing at all angles, and presenting exactly the appearance of sublimed caffeine. The average length of the needles was 0·08 of a millimeter; their thickness somewhat less than 0·006 mm.

It was difficult at first to determine whether the crystals were elevated, or depressed below the surface of the plate, in which case they would have represented casts of crystals dissolved out by the acid; but by careful management of the light, studying the shadows and comparing them with caffeine crystals, they were judged to be in relief. Polarized light had no effect upon them. Beside these crystals, there were observed scattered over the field of view a few irregular etchings, in intaglio, which seemed to be casts of crystalline scales dissolved out by the hydrofluoric acid.

2. A piece of the same plate of glass was treated with successive drops of the acid upon the same spot, waiting to add a drop until the reaction of the former one had ceased.

A deep etching was the result, and the extensively corroded surface presented here and there a ground glass appearance. Acicular crystals were apparent, although not as well defined as in the former example.

Nos. 3, 4 and 5 were slips of the same glass etched by vapor. Of these No. 3 was very slightly corroded; upon No. 4 and still more upon No. 5, the action was of greater duration. In these examples the evidence of acicular crystallization was apparent, as a shading upon the ground glass surface. Toward the edges of the etched spot the needles were as distinct as in example No. 1. Here a few well defined prisms with oblique extremities and one or two very small rhombic tablets were observed.

No. 6. Mirror plate glass. This specimen was corroded by a drop of the acid with greater uniformity than the window glass, although the etching was not so deep. It required careful management of the light to detect the crystals which were observed here and there in the form of scales or tablets, apparently broken and very small. A few acicular crystals were also detected.

No. 7. Plate glass (microscope slide). This specimen, when etched, presented the same appearance as No. 6. Very small acicular crystals distributed sparsely over the field of view could be seen.

No. 8. Three specimens of thin glass covers for microscopic objects. The etching of these was very uniform. Numerous and extremely minute needle-shaped crystals, requiring a high power for their definition, were observed.

No. 9. Green bottle glass (two specimens). In these the crystallization was different from that of the former examples. In some places the etching was granular, as if small and short crystals had been removed by the acid. In other places blade-shaped crystals were apparent; these had a tendency to unite in star-like groups, as in snow. Upon one portion of the plate a few small squares and triangles (insoluble in water) were seen.

No. 10. Two specimens of Bohemian glass combustion-tube etched upon the inside. These yielded a granular, very regular etching, and presented a very delicate ground glass appearance, which was resolved by the microscope into small crystalline tablets or scales, apparently fragments of crystals.

No. 11. Bohemian beaker glass; two specimens, of which one was attacked upon the outside, and the other upon the inner surface of the vessel. Small acicular crystals, resembling those of No. 1, but better defined, and a few squares, triangles and trapezoids were detected.

No. 12. Lead glass tubing; two specimens, etched upon the inside. The action of the solvent was energetic. The etching was granular, with numerous short and minute needles, requiring a high power of the microscope for their definition.

No. 13. A portion of a soda glass flask etched upon the inside. This was corroded very readily and yielded plenty of needles resembling in appearance those of No. 1.

No. 14. Lead glass; inside surface of a matrass. The action of the hydrofluoric acid upon this specimen was energetic. The crystals presented the appearance of confused broken tablets, with here and there a needle-shaped crystal.

The acid employed in the experiments gave no etching when dropped upon the different surfaces of a clear transparent quartz crystal.

No. 15. After having completed the preceding series of observations the object-glass of the microscope was protected from the action of the hydrofluoric acid by cementing upon it a plate of thin glass with Canada balsam. A large number of experiments were then made with slips cut from the same piece of window glass, similar to No. 1, with the object of ascertaining by the microscope whether the residue of the reaction was crystalline, and whether, if so, it could have any influence upon the

etching to give an *appearance* of crystals having in reality no existence.

The acid employed was strong enough to hiss when water was added, and emitted copious fumes. Dropped upon the glass it spread, forming a thin circular cake or film of solid substance having a granular appearance.

By a close inspection small prisms or needles were visible here and there in this residue. They were not as numerous as the etched crystals perceptible when the glass was cleansed, and it was not certain that they were not shadows of the glass crystals. In some cases larger prisms could be seen near the edge of the disc; these might be removed by the needle point; but under them was found no corresponding etched appearance of a crystal.

In one instance the slip of glass was coated with wax for the purpose of confining the acid to a small disc where the glass was laid bare. This gave beautiful crystals, similar to the other specimens. When the plate was covered with a thin film of oil the crystalline etching resulted as in the former instances. When the acid was constantly stirred upon the plate with the platinum spoon employed for dropping it, the crystalline etching resulted as before.

No. 16. At length an etching was found which served as an *experimentum crucis* to the question of the protecting action of the residue. In this case the acid was slightly diluted, but still fumed in the air. The glass, after having been acted upon, contained circular white patches of a ground glass appearance. By the microscope these were resolved into groups of star-shaped crystals which, in some cases, were indistinct from corrosion; in others they were plainly crystals. Their appearance was exactly similar to that of the snow-flake, viz., stars composed of needles which were combined with smaller needles forming feathery rays. In two places long needles of one-eighth of an inch in length were visible. Beside these, the acicular web of the former specimens covered the glass. These starry crystals were undoubtedly in *intaglio*. The depression could be distinctly felt with a needle when observing under the microscope, and fine powder of vermilion filled the rays. When first viewed, before the glass was cleansed perfectly, the corroded remains of the crystals could be removed from the depressions with a needle point.

Now while we can conceive that a crystal formed by the action of an acid, might adhere so closely to the glass as to retard the corrosive effect of the acid under it, it is impossible to see how such a crystal could eat away the glass beneath it and thus sink itself under the surface.

In some of the other specimens these starry groups were perceived; but in no case as distinctly as in this one. There happened here to be groups of crystals which were large and very

favorably disposed for the etching process. The result of this series of experiments seemed to throw some doubt upon the "elevated" character of the acicular web of crystals; at least as much doubt as may arise from the difficulty of judging the question from the shadows. The former conclusion was reached by a comparison of the shadows with those of a web of crystals of sublimed caffeine which were known to be in relief. If in intaglio, their depression is too slight to be able to form a judgment by rubbing the etching with vermilion powder. But as the stars are known to be depressions, it may be that the scattered needles are of the same character.

In some examples, two rays of a star-shaped crystal were seen giving the form of a V, which in other cases was transformed into a triangle by an additional needle happening to lie at its base. The △-shaped crystals described upon a former page may be formed in this manner, although they were not so determined.

It results that the window glass examined contains crystals already formed, of which some are more soluble in hydrofluoric acid than their matrix, and perhaps others less soluble in the same reagent.

All of the specimens of glass submitted to the action of hydrofluoric acid yielded crystalline forms. Those of the window glass are similar in appearance to the crystals obtained by Pelouze by the slow cooling of the same kind of glass after it had been maintained for several hours at incipient fusion. Since in the experiments of this chemist no alteration of weight was observed and the normal character of the glass was restored by simply melting, it is probable that the crystals are of the same nature in both instances. It would appear from some of my observations as if the crystals first formed during the refrigeration of the glass, were subsequently broken by the operations of pressing, rolling &c., to which the material had been subjected.

Doubtless additional interesting phenomena might be observed by a more extended study of different varieties of glass under different conditions by the use of this method.

An analogous action of certain solvents upon other supposed amorphous bodies, as the resins, &c. may demonstrate a crystalline character in them.

From a more extended study of this interesting subject, results the most important respecting the true nature of glass may be expected.

The effect of annealing may here find its true explanation.

If we were able to produce at will an interlacement of long fibrous transparent crystals, a glass of superior flexibility and strength might be obtained. It would also be interesting to ascertain what kind of crystals of different substances might be introduced into glass without destroying its valuable properties.

If such, having the crystalline character of mica or asbestus, could be added a valuable product might result.

Leydolt observed in a slag (see his No. 7) cubic crystals of nearly the same color as the glass and visible to the eye. If we could ascertain the nature of the glass crystals as well as that of the matrix (which may also be crystalline) possibly we might, by the laws of isomorphism, be able to color the crystals at will, thus producing new and beautiful effects in articles of glass-ware. In this connection Leblanc's observation of protoxyd of iron in the transparent portion and but traces of this base in the crystalline part of a specimen of glass, may be noted.

The detection of the crystalline nature of glass demonstrates that we are as yet unacquainted with the true character of this complex substance; but at the same time it indicates the path to be pursued for acquiring this desirable knowledge.

ART. V.—*Contributions from the Sheffield Laboratory of Yale College.* No. IX.—*On the assimilation of complex nitrogenous bodies by Vegetation;* by S. W. JOHNSON.

DURING the summer of 1861 the writer undertook a series of observations on the nutrition of plants, which, though a failure as regards the principal object of the investigation, led to some interesting results. Besides various inorganic matters, the nitrogenous compounds occurring in urine which may be directly applied to crops as fertilizers, viz: urea, guanine, uric acid and hippuric acid, were intended to be made the subjects of experiment.

Washed and ignited flower-pots (of clay, unglazed) were employed to contain, for each trial, a soil consisting of 700 grms. of ignited and washed granitic sand mixed with 0·25 grm. sulphate of lime, 2 grm. ashes of hay prepared in muffle and 2·75 grm. bone-ashes. This soil was placed upon 100 grms. of clean gravel to serve as drainage.

In each of several pots containing the above soil was deposited July 6th, a weighed kernel of maize. The pots were watered with equal quantities of distilled water containing a scarcely appreciable trace of ammonia. But four seeds germinated in a healthy manner, the plants developed slowly and alike until July 28th, when the addition of nitrogenous matters was begun.

To No. 1, no solid addition was made.

To No. 2, was added July 28, 0·420 grm. uric acid.

To No. 3, was added 1·790 grm. hippuric acid, at four different times, viz: July 28, 0·358 grm., Aug. 26th, 0·358 grm., Sept. 16th, 0·716 grm., Oct. 3d, 0·358 grm.

To No. 4, was added 0·4110 grms. hydrochlorate of guanine,

viz: July 28th, 0·0822 grm., Aug. 26th, 0·0822 grm., Sept. 16th, 0·1644 grm., Oct. 3d, 0·0822 grm.

The nitrogenous additions contained in each case, 140 grm. of nitrogen, and were strown, as fine powder, over the surface of the soil.

It not being practicable to attend to the germination of other seeds, urea was not experimented with. This deficiency was of less account, since Cameron's paper on the direct nutritive effect of urea, read before the British Association in 1857, had demonstrated that this substance supplies the plant with nitrogen without previous decomposition in the soil and has a fertilizing effect equal to salts of ammonia.[1]

The plants continued to grow or to remain healthy, (the lower leaves withering more or less,) until they were removed from the soil Nov. 8th.

The plants exhibited striking differences in their development. No. 1, (no added nitrogen) produced in all seven slender leaves and attained a height of seven inches. At the close of the experiment, only the two newest leaves were perfectly fresh, the next was withered and dead throughout one-third of its length. The newer portions of this plant grew chiefly at the expense of the older parts. No sign of floral organs appeared.

No. 2, fed with uric acid, was the best developed plant of the series. At the conclusion of the experiment it bore ten vigorous leaves, six of which were fresh and two but partly withered. It was 14 inches high and carried two rudimentary ears (pistillate flowers), from the upper one of which hung tassels six inches long.

No. 3, supplied with hippuric acid, bore eight leaves, four of which were withered, and two rudimentary ears, one of which was tasseled. Height 12 inches.

No. 4, with hydrochlorate of guanine, had six leaves, only one withered, and two ears, one of which was tasseled. Height 12 inches.

These experiments, together with a large number of others simultaneously undertaken, failed to give satisfactory results from the unfavorable situation of the only apartment at disposition for conducting them in. The light was good but for a small part of the day, and very unequally distributed at that. For this reason, chiefly, most of the plants made but imperfect growth and therefore the laborious analyses which would have properly supplemented the observations on growth were not attempted.

[1] This result has been recently confirmed by Hampe of Göttingen who has made maize to grow as a water-plant with its roots in a dilute solution containing sulphate of magnesia, chlorid of calcium, phosphate of potash, sesquichlorid of iron and urea. Hampe found in the well developed plants—stems and leaves as well as roots—evident quantities of urea.

In the case of the four experiments under notice, the weight of the crops (dried at 212° F.), exclusive of the fine rootlets that could not be removed from the soil, was ascertained with the subjoined results.

No. 1, (no added nitrogen,)	Weight of dried crop,	0·1935 grm.
	" " " seed,	0·1644 "
	gain,	0·0291 "
No. 2, (added 0·420 grm. uric acid,)	Weight of dried crop,	1·9470 grm.
	" " " seed,	·1725 "
	gain,	1·7745 "
No. 3, (added 1·790 grm. hippuric acid),	Weight of dried crop,	1·0149 grm.
	" " " seed,	0·1752 "
	gain,	0·8397 "
No. 4, (added 0·411 grm. hydrochlorate of guanine,)	Weight of dried crop,	0·9820 grm.
	" " " seed,	0·1698 "
	gain,	0·8122 "

We thus have proof that all the substances employed contributed nitrogen to the growing plant. This is conclusively shown by the fact that the development of pistillate organs, which are especially rich in nitrogen, occurred in the three plants fed with nitrogenous compounds, but was totally wanting in the other. The relation of matter new-organized by growth to that derived from the seed is strikingly seen from a comparison of the ratios of the weight of the seed to the increase of organized matter, the former being taken as unity.

The ratio is approximatively

for No. 1,	1	:	0·2
" " 2,	1	:	10·2
" " 3,	1	:	4·8
" " 4,	1	:	4·8

The relative gain by growth, that of No. 1, assumed as unity, is

for No. 1,	1
" " 2,	56
" " 3,	26
" " 4,	26

No examination was made of the soil to ascertain whether the uric acid, &c., had undergone decomposition with formation of ammonia before entering the plant. If urea escapes decomposition, as Cameron and Hampe have shown is true, for the most part, it is not to be anticipated that the more stable bodies employed in these trials should suffer such alteration.

It will be noticed that the gain of dry matter during growth was identical in case of the plants fed with guanine and hippuric acid, and this quantity was again, quite nearly half that mani-

fested by the plant which was supplied with uric acid. Whether this is more than accidental is worthy of study.

From these experiments the writer concludes that the amids resulting from the disorganization of protein compounds, as well as ammonia salts and nitrates, are capable of direct passage into the plant, and there serve for the reorganization of albumen, &c.

Cameron, in the investigation alluded to, remarked that his results demonstrate that it is not necessary that urea should decompose into carbonate of ammonia in order to become available to vegetation, and the above facts warrant the generalization that all the amids existing in the urine of animals are ready for assimilation, without any further resolution by decay. So far as they are directly concerned, then, any "fermenting" of manures of which they are ingredients is useless.

Oct. 1865.

ART. VI.—*Results of observations on the Drift Phenomena of Labrador, and the Atlantic coast southward;* by A. S. PACKARD, Jr., M.D.

THE whole surface of Labrador has passed through a denudation of great extent by continental glaciers. In the southern part of the peninsula, bordering on the gulf of the St. Lawrence, the glaciers evidently moved southward down the slope from the water-shed in the interior. On the eastern or Atlantic coast, at both sides of the mouth of Hamilton Inlet, which is forty miles wide, there are glacial lunoid furrows, like those observed in Maine by Dr. DeLaski, which tend to prove by their direction that a glacier forty or fifty miles in breadth filled this great fiord, and moved in an easterly direction from the water-shed in the interior, thence debouching into the sea.

Owing to the powerful disrupting agency of the frost and ice, the rounded and denuded rocks of Labrador have as yet revealed but few glacial striæ. The distribution of the boulders is restricted to the higher levels of the plateau. To find them in any abundance, it is necessary to ascend 500 to 800 feet above the sea, at which point they occur in profusion. Below this point they have been rolled, rounded, and rearranged into ancient sea beaches. But on the smooth polished quartzites and syenites, the former of which are levelled into broad plains grooved and furrowed and afterward polished almost like glass, with shallow depressions, being glacial troughs filled with water and forming countless pools, and on the rounded syenitic hills which assume dome-like or high conical sugar-loaf forms, we see everywhere in Labrador, below a level of 2000 feet, the traces of ancient glacier action exhibited on a vast scale.

At the close of the Glacial epoch the moraine matter was reassorted into marine deposits, which in this country have been exposed to a general and sweeping denudation. Only small patches are found remaining in sheltered positions. These marine deposits consist of finely laminated clays resting upon coarser, more stony, and gravelly beds. The former were evidently estuary deposits, the latter thrown down in deeper water, where the strong Arctic current prevailed. The oldest beds are the coarser strata, which, as in Maine, occur at high-tide mark. The more recent beds occur from ten to twenty feet above the sea level.

The fossil Invertebrata, found abundantly in these beds, afford excellent material for comparison with the present marine fauna of Labrador, and throw new light on the distribution of marine life during the close of the Glacial epoch. The assemblage is thoroughly Arctic in character, but, when compared with lists of the glacial shells of the north of Europe, it is found to bear a very distinct *facies*. It is evident that on each side of the Atlantic, the same faunal distinctions obtained during this period as now. There was, however, a greater range in space of purely Arctic species, and, though the European marine fauna was much more closely allied to our own, owing to the great predominance of exclusively Arctic forms, it is yet evident that the Arctic glacial fauna was divided into a Scandinavian district, and a Labrador district, each the metropolis of a small number of species peculiar to itself and limited to its area.

The assemblages found at various points along the coast from Labrador to Maine are not the exact equivalents of the present faunæ. They differ in containing a very small percentage of extinct species, and in a different grouping of species still living.

Thus, in the Labrador beds are several species of *Fusus* (Sipho) which differ from recent Arctic forms, and also a species of *Bela;* certain forms, such as *Panopœa* and perhaps *Cyrtodaria*, which were abundant formerly, seem to be dying out at the present day. In Maine the change is still more marked. Thus, the most characteristic shell of the marine clays is *Leda truncata* (*Portlandica*), which has wholly disappeared from the seas south of the circumpolar regions, unless future deep-sea dredging reveals its presence in some of the abysses off our coast. An undescribed *Macoma* is also characteristic of the beds about Portland; and other important changes have occurred in the relative abundance of species, and the manner in which they are grouped as compared with the present assemblages in zoological districts farther north, and similar in physical surroundings to the glacial seas.

The Labrador district of the Arctic fauna, instead of being restricted as now to the eastern coast of North America from the Arctic archipelago to the banks of Newfoundland, and shading

off into the Acadian district at the present line of floating ice, during the Glacial epoch extended up the St. Lawrence river, and as far as Portland, on the coast of Maine, where it shaded into a more southern assemblage.

In Maine there are two distinct horizons of life. The lowest and oldest is found at the bottom of the boulder-clay at high-tide mark along the coast. The second horizon is composed of rewashed, finely laminated, less stony clays occupying the coast from 25 feet above the sea level to a height, 50 to 100 miles inland, of nearly 300 feet. The species found in this second horizon are rather *boreal* forms than purely Arctic. In the beds about Saco and Scarboro' we find *Leda tenuisulcata* intermingled with the Arctic *L. pernula*, as it is not at present on the coast, and *Pandora trilineata* replaces the Arctic *Pandorina arenosa*. At Berwick, *Astarte castanea*, a boreal form, is introduced; while south of this, at Point Shirley, Desor and Stimpson found *Nassa trivittata*, *Buccinum plicosum*, *Astarte castanea* and *Venus mercenaria*, species which now, as an assemblage, abound most on the shores of New England south of Cape Cod, and in New York bay. Again, at Nantucket, Desor found a still warmer fauna occupying, apparently, an extension of this second horizon. *Arca transversa*, *Crepidula fornicata*, with *Buccinum plicosum* and *Nassa obsoleta* were found to abound in this locality, where the warming influence of the Gulf Stream was strongly felt, while the waters of Maine were cooled down by the Arctic or Polar current.

In the beds of this horizon at Gardiner occur the teeth of the bison, walrus, and bones of other animals, and the *Mallotus villosus;* also in the same beds at Bangor the fossil whale, and in Burlington, Vt., in the Champlain clays, which evidently belong to this horizon, the *Beluga Vermontana* of Thompson.

Thus the two glacial faunæ that have successively gained a foothold in northeastern temperate America, seemed, as regards both their land and marine animals, and also plants, (for *Potentilla tridentata* which is found only in Maine, Labrador and Greenland, is also found fossil in the Ottowa clays, according to Dr. Dawson,) to be a purely Arctic American assemblage. According to the view of Dr. Hooker,[2] the most ancient glacial flora was derived from Scandinavia. On the contrary, as far as geological evidence at present tends, the cave mammals of Europe were associated with the musk ox, reindeer, white bear, and other Arctic animals which abound in Arctic America, while no features in the Post-tertiary fossils of America seem to be European. These faunal distinctions would seem to be even more strongly marked than now in the distribution of the Vertebrata during the closing part of the Glacial epoch.

[2] Outlines of the Distribution of Arctic plants, by J. D. Hooker, M.D. Trans. Linn. Soc. London, xxiii, part ii.

ART. VII.—*On a Process of Elementary Analysis admitting of the determination of Carbon, Hydrogen and Nitrogen at a single combustion;* by C. GILBERT WHEELER.

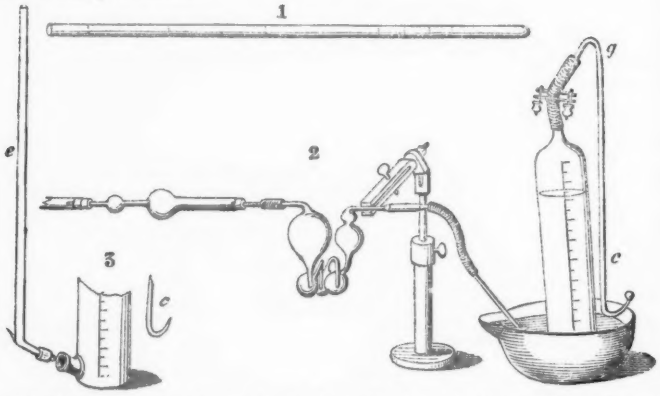
THE processes of ultimate organic analysis heretofore employed, when applied to substances containing carbon, hydrogen and nitrogen, contemplate the determination of the latter element by a *separate* and *distinct operation* and are therefore often embarrassing where the chemist has but a small amount of the substance to be analyzed at his disposal. A method by which these three elements might be determined at a single combustion would appear to be desirable, and, if equally accurate with other approved processes, and also admitting of a not less expeditious execution, might with advantage be employed, not only in the special class of cases referred to, but also in general, as a substitute for those now in use. For some time past I have made use in my laboratory of a method of analysis which apparently is of universal application when carbon, hydrogen and nitrogen are to be determined, and which I can recommend as yielding quite satisfactory results.

The method in question may be considered as a combination, with necessary modifications, of that ordinarily used in determining carbon and hydrogen with Simpson's method of determining nitrogen, as will be seen from the description which I now proceed to give, first in outline, then more in detail.

The operation commences with expelling the air from the combustion tube, by means of a stream of oxygen gas. As in the anterior portion of the tube there is placed a quantity of metallic copper, to prevent the formation of deutoxyd of nitrogen, the former cannot be heated without the copper oxydizing and the tube again becoming wholly or partially filled with air. This is prevented by expelling in turn the oxygen by means of a known quantity of carbonic acid gas, which effected, the combustion proper is commenced and carried on in the ordinary manner with this modification, viz: that, at the close, a current of oxygen gas is again employed for the purpose of forcing into the appropriate apparatus the residuary products of combustion, as also, when necessary to complete the oxydation of particles of the substance yet unconsumed. The water and carbonic acid resulting from the analysis are absorbed in the usual apparatus and weighed, while the nitrogen, mixed with oxygen, is conducted into a special apparatus where it is measured over mercury.

The simplest method would be to conduct the gases into a Bunsen's eudiometer, and in the same perform the necessary

further determinations. However, the capacity of such a eudiometer is not sufficient in the great majority of cases, even where it has a length of 800 to 1000 millimeters. I have therefore made use of Bunsen's gasometer[1] and found the same exceedingly well adapted for the purpose. It has, however, proved desirable to make one or two trifling alterations which in practice I have found to enhance its value and usefulness. Instead of the original arrangement for regulating the escape of gas, I make use of a screw-slip as shown at *g*, fig. 2. Also the tube *c g*, which is not capillary but somewhat larger, is filled with mercury and thus remains during the combustion. The filling is conveniently effected by pouring mercury into the gasometer through the tube *e*, fig. 3, until it passes the point *g*, fig. 2, and flows out in a constant, regular stream at *e*, which is closed with a piece of soft wax. The screw-slip being closed, the gasometer is ready for use.



Both the gasometer above described and the eudiometer, in which the mixture of nitrogen and oxygen is to be analyzed, are graduated, and their cubic capacities referred to a common standard (cubic centimeter). This is necessary, as only an aliquot part of the total gas obtained is submitted to analysis, the greater portion being held in reserve in case any disaster should occur to that under investigation.

I pass now to a detailed description of the mode of procedure in performing an elementary analysis by the process under consideration.

A combustion tube 2–2½ feet in length is sealed up at one end, as shown in fig. 1. From 3 to 5 grams pure, well-dried and pulverized chlorate of potassa are introduced and thoroughly mixed with the aid of a mixing wire, with at least an equal

[1] Bunsen, Gasom. Methoden, p. 21, fig. 16.

volume of freshly ignited oxyd of copper. It is important that the mixture be as uniform as possible in order that the supply of oxygen may be easily regulated. Then follows about two inches of oxyd of copper, and thereupon a weighed portion, from 0·2 to 0·3 gram, of *oxalate of lead* which is likewise thoroughly mixed with oxyd of copper. This salt is the substance I find the most convenient from which to obtain a known amount of carbonic acid gas.

I adopt oxalate of lead in preference to other substances that have hitherto been employed in organic analysis for evolving carbonic acid, as more completely free from the various practical objections presented by the latter, and in particular by the following, viz: carbonate of magnesia (magnesite), carbonate of manganese, carbonate of copper, bicarbonate of soda and oxalic acid. The use of these substances is impracticable, as they either fail to give the theoretical percentage of carbonic acid on being heated, partially decompose when exposed to the air in a moist condition, yield also water with carbonic acid, are too hygroscopic, or present other difficulties that render their use in this process inexpedient. Carbonate of lead is less objectionable than the above mentioned, and it is mainly on account of the greater amount of carbonic acid furnished by the oxalate that I prefer it.

I prepare the latter salt by adding to a solution of acetate of lead a slight excess of oxalic acid, and thoroughly wash the precipitate obtained by decantation. It has the formula PbO, C_2O_3, and yields on gentle ignition with oxyd of copper precisely two equivalents of carbonic acid. As a mean of several nearly identical results I obtained 29·83 p. c. of carbonic acid instead of 29·81 as required by theory. A greater amount of this salt than 0·3 gram being never used, the maximum error, therefore, possible in a carbon determination would be 0·00001643 gram.

After introducing, as previously explained, the oxalate of lead into the combustion tube, about two inches of pure oxyd of copper are added, then a mixture of the substance for analysis with oxyd of copper, and thereupon, again, several inches of the oxyd. Finally, the remaining space in the tube, which should never be less than 4 inches, and need not exceed, except in rare cases, 8 inches, is filled with metallic copper freshly reduced in a stream of hydrogen gas. I prefer for the purpose a compact roll of copper wire gauze.

After a channel has been secured in the usual manner throughout the whole length of the tube—at the posterior end it is well to have the channel larger than elsewhere--a chlorid of calcium tube and potash bulbs are placed in communication as in an ordinary combustion and the anterior end of the latter is connected

by means of a thick piece of gutta percha tubing, about four inches in length, with a glass tube bent at one end so as to admit of being conveniently introduced into the tubulure of the gasometer. The gutta percha tubing taken of the length indicated renders this manipulation much easier. The gasometer having been filled with mercury in the manner previously described, is placed in a suitable vessel, and in a slightly inclined position as shown in fig. 2, directly before the potash bulbs and the tube *e* is removed, the tubulure being submerged in mercury. A small porcelain mortar is a very convenient receptacle for the gasometer.

The apparatus thus put together, and it having been ascertained by the usual method that no leakage exists, the combustion may be commenced. The chlorate of potassa is first heated, and the evolution of oxygen gas continued until its presence is ascertained at the anterior end of the apparatus by the inflaming of a taper; for which purpose, about ten minutes are required. Heat is now applied to the mixture of oxalate of lead and oxyd of copper, and the necessary carbonic acid evolved to displace the oxygen, at least as far as to the anterior portion of the combustion tube. In order to be certain that the metallic copper is surrounded by an atmosphere of carbonic acid gas, the heating of the oxalate of lead is proceeded with until an absorption, usually occurring in from five to eight minutes, is clearly perceptible in the potash bulbs. At this stage of the process it is necessary that the bent tube at the extremity of the apparatus be immersed in the mercury contained in the mortar, in order that during the absorption of the carbonic acid by the potassa there may no air again enter the apparatus. Fire is now applied to the metallic copper; then the oxyd of copper is heated, and the analysis is thenceforward performed precisely as by the ordinary method. When the point is reached where the substance under analysis is situated, the tube at the anterior end of the apparatus is introduced into the tubulure of the gasometer, care being taken that the apperture of the same is not raised above the surface of the mercury. As fast as the gasometer becomes filled with the gases, thus displacing the mercury, the latter is removed from the mortar. The height of the mercury surrounding the gasometer being thus very moderate, merely sufficient to prevent the admission of air, the internal pressure, therefore, upon the apparatus is quite inconsiderable. The combustion of the substance having been effected and the remaining oxalate of lead decomposed, the chlorate of potassa is again heated and the products of combustion completely carried forward to their respective recipients. When the oxygen reaches that portion of the tube previously containing the substance analyzed, a rather vivid but entirely harmless incandescence is observed resulting from the reoxyda-

tion of the copper reduced. The same occurs also when the metallic copper at the anterior end of the tube is reached, at which stage of the process great care is necessary, for, as the oxydation of the copper commences, there is a sudden cessation in the passage of gas through the potash bulbs and one is easily tempted to accelerate the liberation of oxygen. In this event, when the reoxydation is completed, a very sudden and altogether too rapid stream of gas passes through the apparatus and disaster results. If, on the other hand, the liberation of oxygen be not sufficiently rapid, or, in particular, if it should cease for a few moments, the oxydation of the copper would proceed at such a rate and so reduce the tension of the gases within the apparatus as to cause the mercury to ascend the tube communicating with the potash bulbs, and even to enter the latter if not timely observed and prevented by accelerating the stream of oxygen. The one extreme, as well as the other, may be avoided by so regulating the stream of gas that constant but slow oxydation of the copper takes place, and this is readily seen by the change of color that results. Care should be taken that the necessary oxygen be liberated *without interruption* and *uniformly*, which may be easily effected when the chlorate of potassa has been sufficiently pulverized and mixed with at least an equal volume of oxyd of copper.

This somewhat critical stage of the process successfully passed, the supply of oxygen is continued until a considerable quantity has entered the gasometer, which one may confidently assume as accomplished on continuing the stream of gas for about five minutes after absorption ceases to be observable in the potash bulbs. The apparatus is now disconnected and the oxygen remaining in the chlorid of calcium tube and potash bulbs is expelled by air previously freed from carbonic acid and moisture before weighing.

The height of the mercury in and surrounding the gasometer is read off, after the same has been placed in an upright position in a mercury trough with glass sides; also the height of barometer and thermometer. A portion of the gas is then transferred to the eudiometer, previously filled with mercury, in the following manner; the stopper of wax is removed from the extremity of the tube at *c* and the latter is introduced into the eudiometer. The tube *e* is then inserted in the tubulure, and mercury is poured into the same until its level in the tube is above that in the gasometer by about one or two inches. The screw-clip at *g* is then gradually opened and the gas flows out through *c* into the eudiometer. When enough has been transferred for an analysis, the screw-clip is closed, the gasometer removed and the amount of gas in the eudiometer is read off. The further analysis of the gas is performed precisely as in an ordinary air analysis.[2]

[2] Bunsen's Gasometrischen Methoden, p. 74.

A quantity of hydrogen is introduced, the mixture exploded, and, from the thereby resulting contraction in volume, the volume of oxygen present is calculated. This deducted from the volume of the mixture of oxygen and nitrogen gives that of the latter. The relation between the volume of mixed gases introduced into the eudiometer and that originally contained in the gasometer expresses also that of the nitrogen in each apparatus, which total volume thus found is reduced to milligrams and calculated as percentage of nitrogen in the substance under analysis. Should for any cause a repetition of the gas analysis be desirable, a fresh portion is transferred from the gasometer, care being taken that, if the tube *c g* has in the interval been in communication with the air, the first portion of gas be rejected. Ordinarily, not more than one-fifth or one-tenth of the gas contained in the gasometer is taken for analysis.

I herewith submit the results of a number of analyses made for the purpose of testing the process.

1. Urea, $C_2H_4N_2O_2$.

	Theory.	Found.
C_2	= 20·00	19·84
H_4	= 6·67	7·01
N_2	= 46·67	46·40
O_2	= 26·66	26·66
	100·00	99·91

2. Nitrate of urea, $C_2H_4N_2O_2$, HO, NO_5.

	Theory.	Found.
C_2	= 9·756	9·455
H_5	= 4·065	4·342
N_3	= 34·146	33·980
O_8	= 52·032	52·032
	100·000	99·809

3. Uric acid, C_5H, N_2O_2, HO.

	Theory.	Found.
C_5	= 35·71	35·42
H_2	= 2·38	2·49
N_2	= 33·33	33·55
O_3	= 28·58	28·58
	100·00	100·04

4. Urate of ammonia, NH_4O, $C_5HN_2O_2+HO$, $C_5HN_2O_2$.

	Theory.	Found.
C_{10}	= 32·432	32·265
H_7	= 3·783	4·205
N_5	= 37·838	37·330
O_6	= 25·945	25·945
	100·000	99·745

5. Hippuric acid, $C_{18}H_8NO_5$, HO.

	Theory.	Found.
C_{18}	= 60·34	59·993
H_9	= 5·02	5·071
N	= 7·82	7·949
O_6	= 26·82	26·820
	100·00	99·833

6. Hippurate of ammonia, NH_4O, $C_{18}H_8NO_5+HO$, $C_{18}H_8NO_5$.

	Theory.	Found.
C_{36}	= 57·6	57·509
H_{21}	= 5·6	6·017
N_3	= 11·2	10·984
O_{12}	= 25·6	25·600
	100·0	100·110

7. Morphine, $C_{34}H_{19}NO_6$.

	Theory.	Found.
C_{34}	= 71·57	71·742
H_{19}	= 6·66	6·591
N	= 4·91	5·011
O_6	= 16·86	16·860
	100·00	100·204

8. Narcotine, $C_{46}H_{25}NO_{14}$.

	Theory.	Found.
C_{46}	= 64·61	64·483
H_{25}	= 5·85	5·834
N	= 3·31	3·101
O_{14}	= 26·23	26·230
	100·00	99·648

9. Asparagine, $C_8H_8N_2O_6$.

	Theory.	Found.
C_8 =	36·364	36·195
H_8 =	6·060	5·985
N_2 =	21·212	21·009
O_6 =	36·364	36·364
	100·000	99·553

10. Oxalate of ammonia, NH_4O, C_2O_3+2HO.

	Theory.	Found.
C_2 =	19·35	19·123
H_6 =	6·45	6·805
N =	22·58	22·557
O_6 =	51·61	51·610
	100 00	100·095

11. Nitrate of ammonia, NH_4O, NO_5.

	Theory.	Found.
H_4 =	5 0	5·244
N_2 =	35·0	34 876
O_6 =	60 0	60 000
	100·0	100·120

12. Nitrate of potassa, KO, NO_5.

	Theory.	Found.
N =	13·833	13·956

In analyzing the latter substance, it was mixed with carbon obtained by exposing crystallized sugar to a high temperature in a close vessel.

Among the advantages this process of analysis presents may be enumerated the following:

I. The saving of material and time; a single combustion sufficing where two have formerly been found necessary. Where properly conducted two complete analyses can be performed in a day.

II. Its general applicability, which as would appear from the substance analyzed to have the very widest range and to include the most diversified combinations of nitrogen with other elements.

III. The complete oxydation, even of those substances presenting the greatest difficulty in this respect, is perfectly secured, as the combustion is completed in a stream of oxygen gas.

IV. As an additional recommendation may be considered the circumstance that where a loss of carbonic acid has occurred during the combustion, either on account of the potassa becoming too nearly saturated, or a momentarily too rapid oxydation of the substance, this loss may be ascertained, added to the carbonic acid already found, and the analysis thus made satisfactory. As this carbonic acid is to be found in the gasometer, it is simply necessary to introduce a potash ball into the eudiometer and, from the contraction resulting, calculate the amount of carbonic acid present. I have in several instances had an opportunity of proving the value of this supplementary determination, and at the same time of saving analyses otherwise worthless.

In closing, I would acknowledge, with thanks, the valuable aid rendered me during the above investigation, by my assistant, Dr. G. Seelhorst.

Nuremberg, Bavaria, Sept. 15, 1865.

ART. VIII.—*On a new Process for the determination of Sulphur in Organic Compounds, by combustion with Oxygen Gas and Peroxyd of Lead;* by C. M. WARREN.[1]

IN my former communication "On a Process of Organic Elementary Analysis by Combustion in a Stream of Oxygen Gas,"[2] I treated exclusively of the determination of carbon and hydrogen in volatile liquid hydrocarbons,—my experiments up to that time having been confined to the analysis of substances of this class. It was my intention, however, to have applied the process before this to other classes of bodies, and especially to have tested its applicability, with suitable modifications, for the analysis of organic substances containing other elements.

Other work with which I was then occupied, and to which this process was only incident, as already stated in the paper referred to, has prevented me from extending the research beyond the requirements of my other investigations.

Having recently had occasion to determine sulphur in some volatile liquid compounds, for which neither of the processes now in use seemed satisfactorily adapted, I was naturally led to make an effort to utilize my safety-tube and the stream of oxygen in this species of analysis also. But the fact that sulphur is usually, at least, but partially converted into sulphuric acid by combustion in oxygen gas seemed at first to present a difficulty not to be easily overcome. It soon occurred to me, however, that the well-known reaction between sulphurous acid and peroxyd of lead, by which the former is completely converted into sulphuric acid, might probably serve to remove this objection. Furthermore, that, by placing the peroxyd of lead within the combustion-tube in the manner which I shall presently describe, and by maintaining the peroxyd of lead at a temperature sufficient to prevent condensation of water within the combustion-tube, the carbon, hydrogen, and sulphur might all be determined from the same portion of substance. This result has been accomplished.[3]

[1] From the Proceedings of the American Academy, March, 1865.

[2] Proceedings of the American Academy, 1864, p. 251.

[3] Carius (Annalen der Chemie und Pharmacie, 1860, cxvi, 28) has observed that when substances rich in sulphur are burnt with oxyd of copper—a tube containing peroxyd of lead being placed between the chlorid of calcium tube and the potash bulbs in the usual manner—the determination of carbon is too high. And on the other hand he found that, with substances rich in carbon, the determination of the carbon was too low. In the latter case, the peroxyd of lead was supposed to absorb and retain carbonic acid; and in the former, sulphurous acid was found to pass unabsorbed through the peroxyd of lead.

The incomplete absorption of the sulphurous acid may be reasonably accounted for on the supposition that a channel was formed, by handling or jarring, along the top of the peroxyd of lead, which indeed would be very likely to occur in using, by

Referring to my former paper above mentioned for details regarding the construction and use of the apparatus employed, I need here describe only such modifications as have been found expedient to adapt the process to this special purpose.

The combustion-tube being packed with pure asbestus betweeen the points *a* and *b*, fig. 1, and the space—about two inches in length—between *b* and *c* left vacant, a plug of pure asbestus is placed at *c*, and the space between *c* and *d*, about three or four inches in length, then filled with a mixture of pure asbestus and peroxyd of lead, and finally a plug of asbestus is placed at *d*. As the sulphuric acid formed is to be absorbed by, and finally determined from, the peroxyd of lead,—in order to obviate the necessity of treating the whole of the asbestus in the tube to obtain the sulphuric acid, which would be troublesome, and at the same time preserve the asbestus packing in the posterior part of the tube in a fit condition for future use,—it is important that the asbestus plug at *c* should be packed closely enough to prevent any particles of the peroxyd of lead from passing back of this plug.

1.

As already stated, the object of mixing asbestus with the peroxyd of lead is to prevent the formation of a channel along the top. In this manner but a short column of the mixture of asbestus and peroxyd of lead will suffice to secure complete conversion of the sulphurous acid. The combustion is conducted precisely as for the determination of carbon and hydrogen alone, except that the portion of the tube which contains the peroxyd of lead is maintained at a gentle heat, sufficient to prevent condensation of water in that part of the tube and at the cork, but avoiding a temperature which would decompose the peroxyd of lead. As usual, the water formed is absorbed in a chlorid of

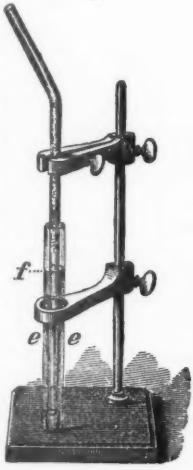
itself, so heavy a powder. Through such a channel sulphurous acid might pass, in so small proportion, without coming in contact with the peroxyd of lead. It will be seen that the liability to the formation of a channel is obviated in my process by mixing the peroxyd of lead with a large proportion of asbestus. The asbestus serves also to increase the porosity of the mass, and in this manner also to lessen the chances of escape of sulphurous acid without coming in contact with the peroxyd. I may here add that, in making the combustion with oxygen in presence of asbestus, the quantity of sulphurous acid which reaches the peroxyd of lead is by no means very large. In a preliminary experiment, in which carbonate of soda was employed instead of peroxyd of lead, (the substance burnt being bisulphid of carbon), the carbonate of soda was found to contain within about 9 per cent of the equivalent of sulphur; and a portion of the deficiency it is not unlikely may have been taken up by the impure asbestus that was employed in this instance.

Concerning the other source of error in the determination of carbon which Carius mentions, it will suffice to remark that, in my process, the peroxyd of lead is kept at so high a temperature that the absorption of carbonic acid appears to be prevented.

calcium tube, and the carbonic acid in Liebig's potash bulbs with a mulder tube attached.

After the close of the combustion, when the tube shall have sufficiently cooled it is carefully removed from the furnace, the mixture of peroxyd of lead and asbestus cautiously drawn out into a beaker glass, by means of a bent iron wire, and the tube then inverted within another tube, *e e*, closed at one end, as shown in fig. 2. The mixture of peroxyd of lead and asbestus contained in the beaker glass is now treated with a strong solution of bi-carbonate of soda, and left to stand for about twenty-four hours, with frequent shaking.[1]

2.



Solution of bi-carbonate of soda is also poured into the tube *e e* until the level of the liquid shall have reached a point, *f*, on the combustion-tube, a little above that which was occupied by the plug *c*, and this is also left to stand as the other. After the lapse of sufficient time for the reaction to be completed, the solution is filtered from the asbestus mixture, including also the solution in the tube *e e*, and not omitting to carefully rinse out the anterior portion of the combustion-tube. The asbestus mixture upon the filter is then thoroughly washed, the filtrate concentrated by evaporation, and the sulphuric acid precipitated with chlorid of barium.

The following results of analyses of bi-sulphid of carbon indicate the degree of accuracy afforded by this process.

The preparation employed was commercial bi-sulphid of carbon, which was first subjected to re-distillation.

Analysis 1. 0·1414 gram of bi-sulphid of carbon gave 0·0806 of carbonic acid, and 0·8592 of sulphate of baryta.

			Calculated.	Found.
Carbon,	C	6	15·79	15·61
Sulphur,	S_2	32	84·21	83·70
			100·00	99·31

Analysis 2. 0·274 gram of the same substance gave 0·158 of carbonic acid, and 1·6768 of sulphate of baryta.

			Calculated.	Found.
Carbon,	C	6	15·79	15·73
Sulphur,	S_2	32	84·21	84·05
			100·00	99·78

[1] H. Rose, Chimie Analytique, new French edition, p. 662.

Analysis 3. In this analysis, in which I was prevented from determining the carbon, 0·1537 of bi-sulphid of carbon gave 0·9461 of sulphate of baryta, corresponding to 84·5 per cent of sulphur.

The mixture of asbestus and peroxyd of lead employed was of that which had already been used in the preceding analyses, and may possibly have contained a trace of undecomposed sulphate of lead, as the per-cent of sulphur found in this case is 0·3 per-cent above, while in the preceding analyses it was a fraction below the theoretical quantity. Trusting, however, that the results already obtained will be deemed sufficient to show the method to be a good one, I have not thought it advisable at this time to further repeat the analysis of this substance. I may here state that I have already applied the process in the analysis of bodies containing hydrogen, and have obtained satisfactory results which will soon be published.

The important advantage thus gained of being able to determine the different elements from the same portion of substance, considering also the simplicity of the process, can hardly fail, I think, to secure for this preference over the older methods.

ART. IX.—*Description of an Automatic Registering and Printing Barometer;* by G. W. HOUGH, A.M., Director of the Dudley Observatory.

THE science of meteorology is as yet in its infancy. Universally interesting as its phenomena have ever been, and powerfully affecting the most important relations of society, it is but recently that the subject has engaged the systematic and combined effort requisite for its development, since its laws are still regarded as the most recondite problem in Physics. The first thing to be done is of course the collection of facts, and much is now being done in England and on the continent in this direction. The chief obstacle, hitherto, has been in the imperfection of the methods of observation. The results, in order to be of value as data from which to construct a science, should present a *continuous* record of the phenomena during a considerable period of time, and taken at as many different stations as possible. By the ordinary method of personal observation, this is well nigh impracticable. It would demand at every station the services of several observers, at great expense, and their results could only at best be more or less of an approach to what is desired. To obtain this, the only alternative is to substitute some mechanical means for the labor of personal observation; in short, to make the instrument record its own changes. If this can be done in a single instance, it can be done continuously.

The only method by which this has been hitherto attempted with success has been by the application of photography. This, though a very considerable advance, and probably all that could be desired in respect of continuity and accuracy of the record, is liable perhaps to the objection that it is too complicated a process for general use. If we consider the skill requisite in the preparation of the paper, the delicacy of manipulation involved by the apparatus, and the labor of interpreting the results, as compared with the average capacity and means of the great number of observers desired and likely to volunteer or be employed for such a purpose, it would seem that a simpler process is both desirable and necessary. This it has been my intention to furnish, and with what success remains for time and experience to determine. The importance of the subject will justify me perhaps in presenting some account of the new method.

The problem to be solved, was to cause any meteorological instrument, by means of suitable mechanism, simply and effectually to record its own changes. The instrument selected for experiment was the barometer. When any delicate instrument is made to record its own changes by mechanical means, the chief difficulty is that of getting sufficient power for the mechanism attached to make a distinct and continuous record, without taking a perceptible amount of force from the instrument itself, and thereby vitiating the results. The use of electricity naturally suggested itself as the best means of overcoming this obstacle. This agency has not as yet been made economical or certain as a motor, but is chiefly valuable in controlling power obtained through some other means. By it, as may be seen in its application to clock work, and in the telegraph, the movements of one machine may be reproduced in an other with no greater expenditure of force than is requisite for electrical contact. In the cases cited, however, the motion to be reproduced is sensibly uniform and in the same direction. For the solution of our problem, a mechanism is demanded that shall repeat the changes of the original in every form, whether the motion be uniform or variable, forward or reverse.

The feasibility of this plan was discussed with my friend Mr. Thomas Simons as early as the year 1862, and some steps were then taken to apply it to the thermometer. I may here express my acknowledgments to Mr. Simons for valuable suggestions in the construction of the present machine. Various plans were considered for effecting the electrical contact with the fluctuating medium which is the basis of this method. It was at first proposed to do this at the surface of the mercury in a siphon barometer, by means of a platinum wire which should be carried continually toward the mercury surface by suitable mechanism, and on touching the surface, a galvanic current would be formed

which should operate by an electro-magnet on the mechanism so as to reverse the motion of the wire and break the circuit. This would be immediately restored by the normal movement of the mechanism, and thus the point of contact would be kept oscillating *at* the surface continually. The consumption of battery power by this plan would have been considerable, and it was thought the oxydization of the mercury by the electric circuit would in time be appreciable. It was therefore concluded to make the connection outside of the barometer tube, by means of a float resting upon the mercury column. By this plan there is no demand of action from the battery until some change takes place in the barometer, and a considerable saving of battery elements is effected.

Attention was then given to determining the degree of delicacy with which changes of the mercury surface could be represented by this process. It was found by experiment that a motion of less than ·0005 of an inch was readily shown, a quantity within the limits of reading of a first class standard barometer.

The next step was to devise the proper mechanism for repeating the motion thus transferred, and recording it in some legible form. A finely cut screw was considered as best adapted to measure such minute intervals of space. To this screw a forward or reverse motion was given by a double system of clock work, each operated by an electro-magnet in connection with the float, and raising or lowering the screw by intervals corresponding with the changes indicated in the mercury column.

In respect to the permanent record of results, it was decided not only to attempt the production of a linear diagram or curve of atmospheric pressure, as an interesting method of presenting the recorded changes to the eye, but to avoid the tedium and uncertainty of measuring up such results, by producing at the same time a printed record of such variation, to any extent deemed advisable.

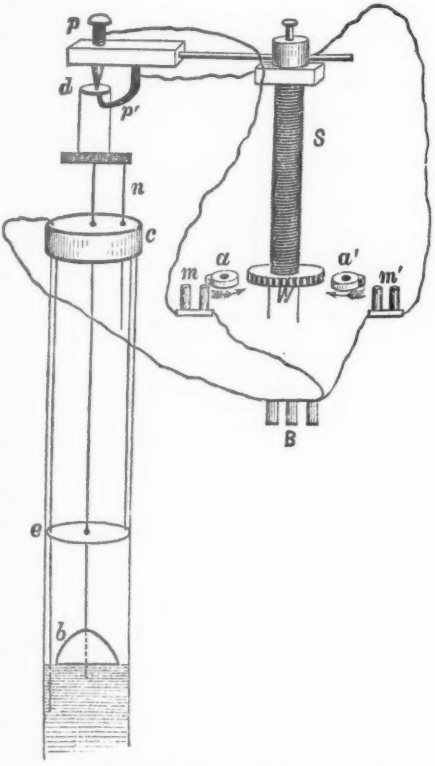
Having thus endeavored to give some conception of the design and principal features of this method, I will proceed to explain more fully the details of its execution as at present arranged.

In order to make any self-recording machine of this kind practicable, we need to attend to two points. First, to reduce the consumption of electricity to the smallest possible amount consistent with certainty in the results; and secondly, to secure the greatest amount of useful work with the minimum of labor. We at once decided to adopt the "make" circuit; for so long as there is no motion, there will be no consumption of battery elements. The battery which we have adopted for recording transits is essentially that of Daniell; sulphate of copper being the exciting agent. A battery of this kind will maintain sufficient power for chronographic records for two or three months,

without being cleaned; it being only necessary to add a little sulphate of copper and water from time to time, to supply the necessary waste. The only power demanded of the electro-magnets is the unlocking of the mechanism, which is driven by weight power.

In fig. 1, we have a sectional view of the lower leg of the siphon, showing the principle on which this method is based. It may be necessary to remark, however, that the electro-magnets and battery do not occupy these positions in reality, but are placed here for convenience of illustration.

1



Let B = battery.

" m, m' = electro-magnets.

" a, a' = wheels having one tooth, and revolving in the direction of the arrows.

S = screw supporting the arm, carrying two wires, p, and p' tipped with platinum.

d = platinum disk carried by the float b.

The two wires, p, p' are respectively above and below the center of the disk d.

W = wheel with 40 teeth in which is inserted the screw S.

n = a small steel wire passing through the brass cap c, to prevent the disk d from revolving.

e = an ivory disk inserted in the tube, to prevent the float b from rubbing against the sides of the tube.

Now suppose the mercury should rise in the short leg of the siphon, as represented in the figure. The float b will be raised, and cause the platinum disk d to come in contact with the point of the platinum wire p, closing the circuit through the electro-magnet m; the armature of which being attracted, unlocks the

clock-work, and allows the wheel *a* to make a complete revolution. By this means the wheel W is advanced one tooth, which raises the screw S the $\frac{1}{200}$ of an inch, and consequently carries the point *p* that distance away from the disk *d*.

As long as the mercury rises, the magnet *m* will be operated, and the platinum point *p* will be kept the $\frac{1}{200}$ of an inch above the disk *d*.

If, on the contrary, the mercury falls in the siphon, the under side of the platinum disk *d* will be brought in contact with the point of the wire *p'*, thereby closing the circuit through the magnet *m'*; the armature of which allows the one tooth wheel *a'* to make a complete revolution, thereby causing the screw S to be depressed the $\frac{1}{200}$ of an inch, carrying of course, the platinum point *p'* with it.

It will now be readily seen how the platinum disk *d*, carried by the float *b*, may always be maintained midway between the two points *p* and *p'*, and distant a little less than the $\frac{1}{200}$ of an inch from each.

The barometer is of the siphon form; the inside diameter of the portions near the surface of the mercury is nearly one inch. The upper and lower portions were made from the same glass tube, the two being connected by a tube of smaller diameter. The experiments and observations, so far, indicate that there is no appreciable difference in the size of the two legs of the siphon.

The float *b* is of ivory; the form a paraboloid of revolution. The under side of this float is very slightly concave. The diameter is one-tenth of an inch less than the inside diameter of the tube, so that there is no friction between the sides of the float and glass. The platinum disk *d* is supported by a steel wire passing through a brass cap *c* fitted on the top of the tube, and an ivory disk *e* inserted at a distance of $2\frac{1}{2}$ inches above the float *b*. The ivory disk is connected with the brass cap by means of two wires, so that it can readily be removed. A light steel wire *n* passes through a hole in the cap, for the purpose of preventing the disk *d* from revolving. This is made sufficiently free to prevent any friction.

The disk *d* is made of brass one-half an inch in diameter, and is covered on both sides with platinum plates.

The wire *p* is attached to a fine screw, for adjusting the distance of the points *p* and *p'* from the surface of the disk *d*.

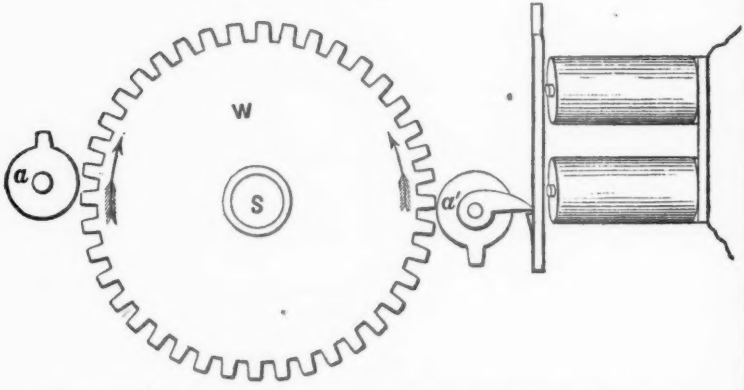
These wires *p* and *p'* are, of course, insulated by being attached to an ivory block, as shown in the figure. The wires from these points are led to the top of the screw S, where they are fastened to an ivory block, after which they are connected with the electro-magnets *m*, *m'*.

A platinum wire is inserted in the side of the barometer tube,

and passes down in the mercury on the side of the float *b*. This wire is also connected with one pole of the battery.

The principle employed for giving motion to the screw S, which follows the fluctuations of the mercurial column, has been taken from the stop work long used on clocks. The barrel of a clock on which the cord is wound usually has a one-tooth wheel on its axis; and at every revolution of the barrel, a cog wheel is made to advance one tooth. This cog wheel is, of course, always detached from the barrel tooth wheel, except when in the act of advancing the tooth. In fig. 2, we have a vertical view of a portion of the mechanism, showing the method of communicating motion to the screw S. The one tooth wheels, *a a'*, when at rest occupy the positions as shown in the drawing; and being detached from the cog wheel W, it is free to move in either direction. The screw S, which is shown in fig. 1, is raised

2.



or depressed by the revolution of the wheel W. The one-tooth wheels *a* and *a'*, moving in the direction of the arrows, give opposite motions to the wheel W; the office of *a* being to elevate the screw, and of *a'* to depress it, corresponding to the fall and rise of the mercurial column.

The mechanism for giving motion to the wheels *a* and *a'* is ordinary clock work, each being directly acted on by the barrel wheel, which is driven by a weight. One revolution of the barrel corresponds to twelve of the wheels *a* and *a'*. The axles, to which are attached *a*, *a'*, carry another wheel having a single half-tooth, as shown in the drawing, fig. 2, which, resting against a little projection on the armature of the magnet, holds the wheel in the position as shown in the figure.

In order that the wheels a and a' may not revolve with too great rapidity, a train of clock work is connected, consisting of two additional axles, a fan being attached to the latter, by means of which the motion can be regulated to any desirable velocity. Three axles would undoubtedly be sufficient, the barrel axle, the axles a, a', and an additional one for the fan. We adopted the present form, because we happened to have a couple of clock movements at hand, and used them just as they were.

In order to prevent the cogs of the wheels a, a', from coming to the circumference of W at the same time, during rapid oscillations of the barometrical column, two circuit-"breakers" were connected; so that, at every revolution the circuit is interrupted, and neither wheel can revolve until they both are at rest.

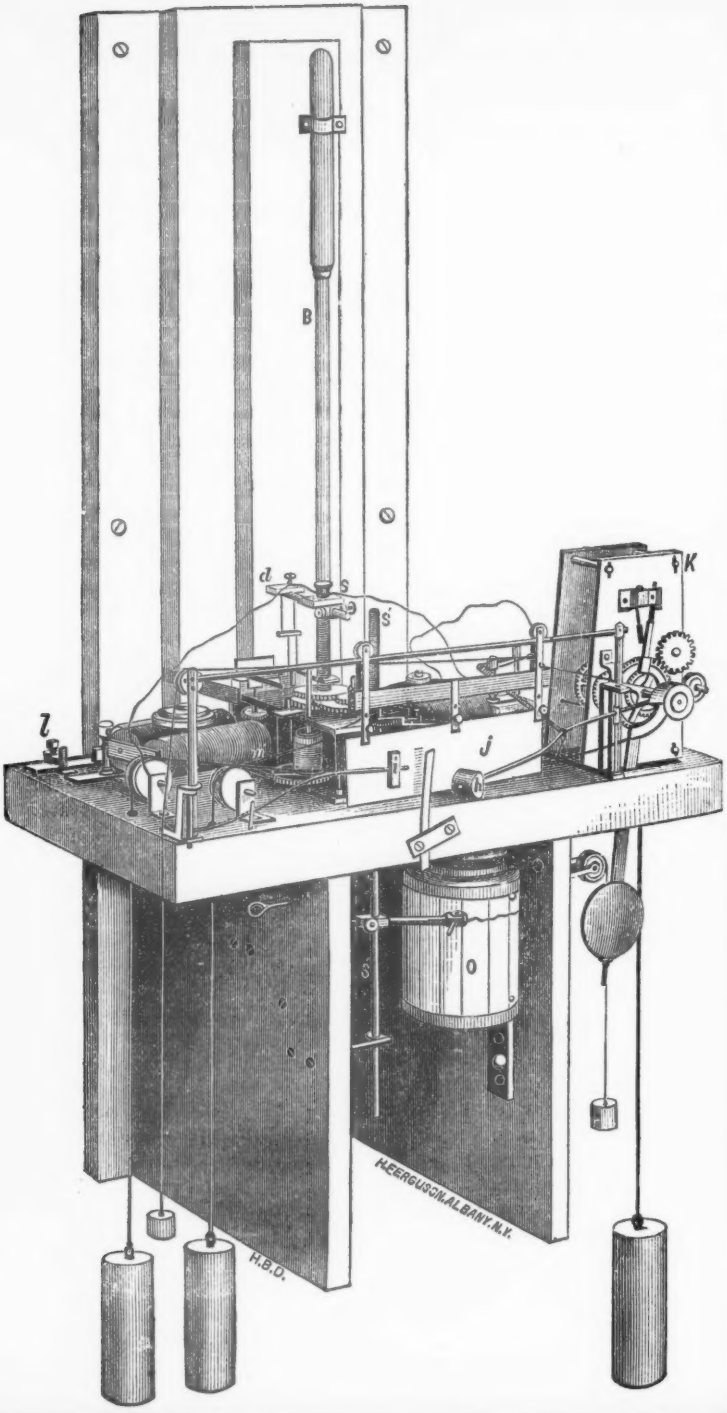
Fig. 3 is a perspective view of the apparatus as it is when in operation. The frame work for supporting the barometer tube and other mechanism is of black walnut two inches thick, which is firmly fastened to the east wall of the west transit room. This wall is built of brick, and is two feet thick, so that the whole apparatus occupies a very firm position.

Having given a general idea of the mechanism for causing the screw S to follow the motions of the barometrical column, we will show how the curve of pressure is recorded, as well as the printed results.

The wheel W, fig. 2, which receives the impulses, has 40 teeth; and the screw S, having 50 threads to the inch, one tooth of the wheel W corresponds to the $\frac{1}{2000}$ of an inch change in the barometrical column, or $\frac{1}{1000}$ of an inch change of pressure. To the wheel W is attached another of nearly the same diameter, having 80 teeth; this wheel is geared into one of 40 teeth carrying an 80-tooth wheel on the same axle. This second 80-tooth wheel is geared into a 50-tooth wheel, which operates the screw S′, fig. 3, of 26 threads to the inch. To this screw is attached an arm, carrying a pencil which traces the curve of pressure on the revolving cylinder o.

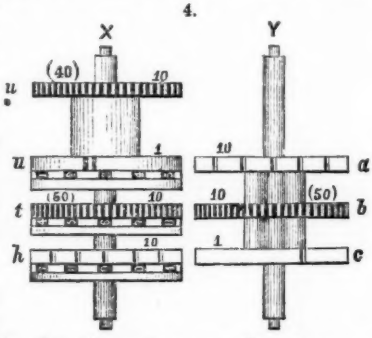
From this arrangement, the curve is magnified a little more than three times the barometrical pressure. It would have been an easy matter to adapt the second screw and cog wheel, so that the curve would be exactly an integer scale—say 1, 2, 3 or 4 times; but as our printed results may be obtained much more accurately, and as often as is necessary, it was not thought of sufficient importance to construct a screw especially for this purpose.

We will now explain the mechanism for printing the results.


B
d
s
s'
K
l
m
j
o
H.E.D.
HEERGUSSN.ALBANY.N.Y.

A sectional view of the combination is shown in fig. 4, where X and Y are two vertical steel axles. The final result expressed in thousandths of an inch, is found on the axle X, where u is the units wheel, t tens, and h the hundreds; or where the thousandth of an inch is the unit of measure, u will represent thousandths, t hundredths, and h tenths of an inch.

4.



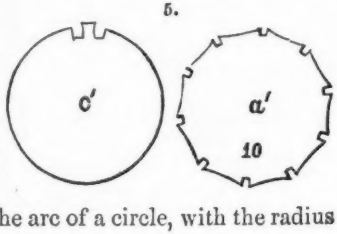
The wheel u_o may be supposed to have ten teeth, and is connected with u, so that they move together. If motion be given to u_o, so that it move one tooth at each impulse, each tooth will represent the $\frac{1}{100}$ of an inch; and ten impulses, or a whole revolution, will represent the $\frac{1}{10}$ of an inch. The wheel u has one tooth, and the wheel a on the axle Y has ten teeth. Now when u has made a complete revolution, it will have advanced a one tooth or one-tenth of a revolution; consequently the wheel a will always express the hundredths.

In order to transfer the motion of a to the axle X, we fasten to a the wheel b, having ten teeth; and by gearing this in the wheel t, having ten teeth also, we transfer the motion of a to t, hence we have the thousandths and hundredths expressed on the wheels u and t.

But let us go a step further, and see how we get our tenths. The wheels a, b, we have shown, indicate the hundredths; we therefore attach to them another wheel c, having one tooth. Let the wheel h of ten teeth be placed opposite. Now when the axle X, carrying the wheels a, b, c, has made one complete revolution corresponding to one tenth, the wheel h will have advanced one tooth; consequently the tenths will be represented on the wheel h.

It is of course understood that the wheels u, t, h, are separate, and free to move about the axis X. By repeating this combination, we can employ any number of figures we choose.

5.



The wheels u, h, a and c, are made after the plan employed in the stop work in a chronometer. In fig. 5, a' and c' indicate this form of gearing. It is seen that the teeth of one wheel are cut in the arc of a circle, with the radius

equal to that of the wheel into which it gears. This arrangement prevents any motion, except it be communicated by the units wheel. The whole mechanism is therefore locked together, and it is just as impossible for it to get out of order as it is for ordinary clock gearing.

The chief merit of this combination is, that it will carry for ten either forward or backward. This principle is necessary in any meteorological printing instrument. We need no extra apparatus for bringing the type in line, since if the mechanism is well constructed, it will always arrange itself. When once set it will remain so, for no change can be made without ungearing the machine.

We use ordinary type which are set in separate disks, being afterwards screwed fast to *u*, *t*, and *h*. In case a type is accidently damaged, or broken, another can be inserted in a few minutes. Steel type would undoubtedly be the best, as being more durable and less liable to damage. We should add, that the wheels *t* and *b* have each 50 teeth; five teeth being moved at one impulse.

The printed results are received on the strip of paper *j*, moved by the clock-work *k*, fig. 3, which at the same time regulates the revolving cylinder *o*, on which is traced the curve of pressure. This same clock raises a small hammer *h*, by means of a screw or spiral on the minute wheel arbor, which at every revolution is allowed to strike the small cushion *i*, by that means leaving the impression of the type on the paper strip. In order to secure greater distinctness in the printed results, without employing much power to make the impression, a strip of duplicating impression paper is inserted between the type and ordinary sheet of white paper.

We are not limited in our printing to hourly records, but they can be obtained as often as it is desirable, by supplying the additional power required to raise the hammer. The clock for moving the printed slip and cylinder is an ordinary half-second's pendulum, which we happened to have at hand. It was not thought necessary to print the integer number of inches, nor the time; for the paper slip has the time already printed on the side, so that when the record of the day is completed, it is only necessary to add the date and integer inches.

The following is a *fac simile* copy of the record as printed by the machine. The numbers on the left hand are the hours from noon of the 11th to the noon of the 12th. The remaining figures are the barometrical heights expressed in thousandths of inches.

DUDLEY OBSERVATORY.

May 11*th*, 1865.

Time.	Barometer. 29 *in.*		
HOURS.			
0	7	0	4
1	6	9	6
2	7	0	9
3	6	8	8
4	6	9	2
5	6	8	1
6	6	9	0
7	6	8	9
8	6	8	0
9	6	6	2
10	6	5	8
11	6	7	0
12	7	3	6
13	7	0	0
14	7	0	1
15	7	1	8
16	7	7	6
17	7	8	3
18	7	8	4
19	7	8	9
20	7	9	0
21	7	8	3
22	7	8	5
23	8	0	1
0	8	0	4

One of the peculiarities of this method is, that we can print our results at any number of places, provided we have telegraphic communication. One standard barometer may be made to record its indications at fifty different points at the same instant.

The accompanying lithographic sheet exhibits a few of the more remarkable diurnal barometric curves as recorded by our apparatus. The first three curves belong to the scale as given at the top of the sheet; the remaining ones to that given at the bottom. The height of the barometer is given for noon of each day. The scale of the curve is 3·077 times the barometric pressure. From these data, the barometric height for any other time can be deduced.

The following remarks will show the apparent atmospheric condition at the time.

May 10th. Bar. 29·91 in. Cloudy, a light breeze from the south. The violent agitation of the barometrical column, clearly indicates an approaching storm. The small amount of depression, however, shows that this storm will not be very violent at the place of observation.

We may here remark, that a few months observation by this method, has led us to surmise, that the barometer as a weather indicator, does not depend so much upon the amount of the variation, as upon its quality. If the barometer is depressed 0·2 or 0·3 of an inch, and the curve is smooth and regular, it does not indicate a sudden change. But, if the curve exhibits a violent tremor, it may be taken as a good indication of an approaching storm. In how far these views are correct can only be determined by a long series of careful observations.

May 11th. Bar. 29·70 in. The curve is rather a remarkable one, from the fact that apparently there was but little atmospheric disturbance at this place. It shows, however, that the atmosphere was in a violent state of agitation, from 3 P. M. of the 11th, to 4 A. M. of the 12th. During the afternoon of the 11th, the weather was very changeable; clouds were continually pass-

ing over the heavens. At 6 P. M. it began to rain; and continued with intervals of intermission until sometime after midnight. During the afternoon and evening, the wind blew rather strongly from the southwest, but was at no time very violent here. But at other points 200 miles to the east and south of this city, the wind blew a tornado, doing considerable damage to property. At New York, it was most violent between 6 and 7 P. M.

June 26th. Bar. 29·68in. Cloudy, a heavy shower of rain followed immediately after the depression at 4 P. M. A violent gale of wind 150 miles to the east, about midnight.

July 16th. Bar. 29·81in. Rain after 8 P. M.
July 19th. Bar. 29·69in. Rain.
July 26th. Bar. 29·60in. Cloudy, light breeze from south.
Aug. 4th. Bar. 29·94in. Heavy showers from 6 to 10 P. M.
Aug. 12th. Bar. 29·72in. Clear and pleasant.
Aug. 16th. Bar. 29·73in. Rain—storm between 6 and 8 P. M.
Aug. 22d. Bar. 29·65in. Rain.
Aug. 29th. Bar. 29·94in. Clear.
Oct. 17th. Bar. 30·20in. Clear.
Oct. 18th. Bar. 30·04in. Cloudy with some rain. A violent gale of wind on the night of the 19th; most severely felt along the eastern coast. The observations of the 17th and 18th of October were made at New York city. At 14h the weight for driving the mechanism rested on the floor. The barometer at 9 A. M. of the 19th stood at 29·40in.

One great advantage in the use of this instrument consists in the ease with which it may be manipulated. All the adjustments are simple and easily accomplished. Any person could learn, in a few days at most, to keep it in running order, and make any adjustments, should it become necessary from accident or other causes. No chemicals are needed, except the sulphate of copper for the battery, which may readily be procured in any town or village. Every part of the action is visible to the eye of the observer, so that in case any part gets out of order, it will readily be seen.

The screw S, on which the accuracy of the results will in a great measure depend, is, as before remarked, 50 threads to the inch, and was cut by Mr. Charles Fasoldt; and is found to be a very perfect one.

Numerous experiments have been made to test the stability of the float and magnetic connections. It will hardly be necessary to give the results in detail. In case there was no friction of any kind, the float ought always to assume the same position for the same height of the mercurial column. The following is the test we have applied. The electrical contact being broken by the key *l*, fig. 3, the screw S was turned so as to force the

float into the mercury 0·010 of an inch; after which, the current was established, and the float was allowed to take up a position of equilibrium. The same thing was repeated, by turning the screw in the opposite direction and lifting up the float. From many trials, it was found that there was rarely a difference of 0·002 of an inch, and usually less than 0·001 of an inch, from the original position. The same test was applied for larger disturbances, viz: 0·020 or 0·030 inches, with nearly similar results. This is not a fair test, however, since these conditions are never realized in practice. From all our experiments so far, we see no reason why the machine should change its zero any appreciable amount, during a whole year or greater length of time.

The following extracts from our record book will best illustrate the stability of the mechanism.

July 4th. The machine was "blocked" for 6 hours. During this time, the barometer rose 0·070 of an inch. After the float assumed its position of equilibrium, the zero of the machine, by comparison with the standard, was found unchanged.

July 20th. The float was screwed up and down 0·200 of an inch, to see if there was any friction. After assuming its position of equilibrium, the zero was found unchanged.

Aug. 17th. Float taken out of the barometer tube to put in a heavier platinum wire. The zero was changed 0·005 of an inch; mostly due to the larger wire displacing a greater amount of mercury.

The daily comparison of the printed records, with the readings obtained from the standard barometer (Fastré), gives for the mean error of a single result $\pm 0{\cdot}0035$ in. This determination is based on the hypothesis, that the error of reading the standard barometer, is zero; which we know is not the case. From many experiments we have found that the error of reading a first class standard barometer may amount to 0·003 of an inch; chiefly due to the uncertainty in bringing the mercury in the cistern to the zero of height. This difficulty we have shown can be obviated by using a magnetic connection.

The results of observations during three months by this method has demonstrated its eminent practicability. The following table exhibits the diurnal variation of the barometer for the months of June, July and August.

The 1st column indicates the hours: 0 hours being noon. The next three columns exhibit the mean height at each hour, for the whole month. The 5th column is the mean for the three months. These numbers are thousandths of inches; the integer inches being 29.

In reducing these observations, 4 days in June were rejected because the records were incomplete. On those days the machine was disturbed to make some alteration, or failed to per-

form its office. As the method was only first tested during the latter part of April, there were many mechanical details to be

Hours.	June.	July.	August.	Mean of the three months.
0	887	787	851	842
1	878	778	838	831
2	867	772	824	821
3	854	764	811	810
4	847	759	804	803
5	Min. 842	754	Min. 803	Min. 800
6	842	Min. 754	806	801
7	846	758	816	807
8	852	764	827	814
9	866	777	838	827
10	869	783	841	831
11	Max.$_o$ 872	Max.$_o$ 787	840	Max.$_o$ 833
12	872	781	Max.$_o$ 842	832
13	869	775	840	828
14	869	770	839	826
15	Min.$_o$ 867	Min.$_o$ 768	Min.$_o$ 839	Min.$_o$ 825
16	872	773	842	829
17	883	783	851	839
18	892	791	866	850
19	899	801	870	857
20	Max .902	810	Max. 870	Max. 861
21	900	Max. 811	869	860
22	896	808	864	856
23	892	804	853	850

attended to, in order to insure certainty and accuracy in the performance of the mechanism. It is now believed, however, that we have overcome all mechanical defects.

The results for maxima and minima are as follows:

	Min.	Max.$_o$	Min.$_o$	Max.
June,	5 P. M.	11 P. M.	3 A. M.	8 A. M.
July,	6 "	11 "	3 "	9 "
Aug.	5 "	12 "	3 "	8 "
Mean,	5 "	11 "	3 "	8 "

These results differ somewhat from those heretofore adopted. In how far this is due to the season, or the geographical position, can only be determined from a long continued series of observations. The small differences for individual hours near the times of maxima and minima, even in the mean for a month, show us with what small quantities we have to deal in the determination of the principal points in the diurnal curve. In order, therefore, to arrive at any definite conclusions, it is necessary to secure the most accurate results attainable.

One of the greatest impediments in the prosecution of any branch of physical science, is the large amount of personal labor requisite for the reduction of observations. By our method this labor is reduced to such an extent, that the saving in this particular for a single year, would probably be equal to the original cost of the apparatus.

The present barometer has recently been compensated for temperature, by supporting the tube on a brass rod. Previous to this, the instrument was set to the height given by the standard reduced to 32° Fahrenheit; and differential corrections applied to the printed results.

We propose, however, to construct a siphon which shall have the elements of compensation within itself. My attention was first called to this method by Dr. James Lewis, who has discussed the subject, for a steel siphon, in the September number of this Journal.

The whole theory of a siphon compensation depends on this fundamental proposition, viz: If the atmosphere will support 30 inches of mercury at 0° Centigrade, at 100° C. it will support $30+30+e=30{\cdot}540$ inches; e being equal to 0·018, the expansion in volume of mercury for 100° C. If now in a siphon barometer, the increased length of the whole column, when the temperature is raised from 0° to 100° C., is equal to $30\div e=0{\cdot}540$ inches; the surface of the mercury in the short leg of the siphon will remain at the same zero of height for all temperatures, at 30 inches of pressure. Put $e'=0{\cdot}016$ the expansion of the mercurial column in a glass tube for 100° C.

Let $2m$= length of mercury in the equal legs of the siphon in which the diameter is unity.

l= length of intermediate column.

d= diameter of intermediate column.

h= height for which the compensation is to be computed.

Then we have the following general formula:

$$(2m+ld^2)e'=he.$$

It is readily demonstrated that all siphons of the same diameter, in the equal legs, will require the same volume of mercury for compensation.

If the siphon be of uniform diameter throughout, it will require 33·7 inches of mercury to compensate at 30 inches of pressure.

A tube of this form will hardly give a sufficient length of mercury in the short leg. In order to attain the necessary length, we connect the two equal legs with a tube of smaller diameter.

The following values have been calculated, to aid in the construction of a tube:

d.	*m.*	D.	W.
0·70	8·5 in.	0·2 in.	0·62 lbs. Troy.
0·75	7·2 "	0·4 "	2·50 "
0·80	6·0 "	0·6 "	5·61 "
0·85	4·6 "	0·8 "	10·00 "
0·90	3·1 "	1·0 "	15·64 "

The following constants and reductions have been adopted.

$h = 30$ inches, $l = 34$ inches.

D = diameter of the equal legs of the siphon.

W = weight of mercury necessary to compensate.

It will be best to adopt $d = 0{\cdot}80$. After the tube is filled to the theoretical height, the whole apparatus can be subjected to different degrees of temperature, in the same manner as the compensation of a pendulum. By reading the standard barometer every quarter hour, during the progress of the experiment, the exact error of compensation can be determined; and by adding or substracting mercury, the compensation can be perfected. In a siphon that is compensated for 30 inches of pressure, the correction for different degrees of pressure and temperature will be very small; since for 1 inch and 100° C., the correction will only amount to 0·018 inches. The largest correction required will rarely amount to 0·004 inches.

The principle of electrical contact, on which this method of recording minute changes in the height of the barometrical column is based, can with equal facility be applied to the thermometer, anemometer and rain-gauge, and the results printed if desirable. The same form of mechanism can be used with all the instruments, with, perhaps, some slight modifications in the details.

Dudley Observatory, Oct. 28, 1865.

ART. X.—*Observations upon Shooting Stars in November*, 1865.

1. *At New Haven.*—On Monday morning Nov. 13th, 1865, a party of four observers, Prof. W. D. Whitney, Mr. C. G. Rockwood, Mr. Isaac Pierson, and the writer, watched for an hour and fifty minutes beginning at five minutes before four. Those meteors whose paths if extended backward were estimated to cut across the area bounded by the stars in the curve of the sickle in Leo, that is, by the stars η, γ, ζ, μ, and ϵ Leonis, were counted as conformable. The following was the result of the count.

From	3^h	55^m	to	4^h	0^m,	that is, in	5 min.	2	uncon.	14	conf.
"	4	0	"	4	15	"	15 "	10	"	51	"
"	4	15	"	4	30	"	15 "	7	"	57	"
"	4	30	"	4	45	"	15 "	13	"	63	"
"	4	45	"	5	0	"	15 "	7	"	39	"
"	5	0	"	5	15	"	15 "	13	"	57	"
"	5	15	"	5	30	"	15 "	12	"	45	"
"	5	30	"	5	45	"	15 "	6	"	34	"
						Total in	110 min.	70	uncon.	360	conf.

This gives a total of 430, or 235 per hour. The sky was very clear over head, except for a short time about five o'clock, but distant clouds interfered in the north and west nearly all of the time so as to conceal nearly or quite one-fifth of the sky in those directions. About $4^h\ 45^m$ the clouds in the north and west increased, and during the next quarter hour they probably concealed one-fourth of the meteors. They had some effect also in the next quarter-hour. The moon was shining all of the time, being then three days past the quarter. During the last half hour the twilight was increasing quite rapidly.

The position of the radiant was observed with care. It did not seem to be accurately a point, but rather a small area. The center of this area was very near the center of the curve formed by the stars above mentioned, say in R. A. 148°, Dec.+23°. Its dimensions could be only vaguely determined, but were probably not more than 3° or 4° in any direction.

The proportion of the meteors that left trains was larger than usual. The unconformable ones were in general less bright than those that were conformable. It was remarked that more than usual were to be seen near the horizon.

One brilliant meteor which exploded with a green light between Polaris and the zenith left a train for more than a minute. This train shortened and curled up into a crescent, floating ing to the *northward*, showing thus the direction of the wind in the higher regions of the atmosphere. Such apparent motion might indeed in this case have been due to a descent vertically of the luminous cloud. But a similar train was seen south of the zenith which moved also *northward*. The two motions are inconsistent with a vertical descent of both trains.

On the same morning Mr. F. W. Russell observed in New Haven by himself, beginning at $3^h\ 35^m$ A. M. Between that time and four o'clock he saw 25 meteors. Between four and five o'clock he saw 78, making in all 103 in 85 minutes. During the last ten minutes of the watch the clouds obscured the sky, and the moonlight interfered throughout.

The next night was cloudy at New Haven, and nothing could be seen.

On the night of Nov. 14–15th, twelve students began to count at midnight and saw 186 shooting stars in three hours, 69 during the first hour, 52 during the second hour, and 65 during the the third hour. The clouds interfered somewhat in the second hour, and there was a slight haze along the horizon. Seventy of the shooting stars were reported as comformable. A considerable portion of these, doubtless, belonged to the sporadic meteors.

2. *At Philadelphia.*—Mr. B. V. Marsh observed in Philadelphia as follows on Monday morning:

From	1h	20m	to	1h	40m	that is, in	20	min.	16	meteors.
"	1	46	"	2	0	"	14	"	4	"
"	2	8	"	2	28	"	20	"	13	"
"	2	49	"	3	15	"	26	"	24	"
"	3	15	"	3	31	"	16	"	9	"
						Total in	96	"	66	"

Nearly all were comformable. The position of the radiant was carefully noted and located at R. A. 148°, Dec.+24°. Mr. Marsh observed from a window facing northeast. He estimates that had he been in the open air he would have seen about twice as many, that is, that the hourly number for a single observer would have been about 75.

On Tuesday morning, Nov. 14th, Mr. Marsh with a party watched till after 3 o'clock. He says "the weather was good, and we saw a few meteors, but the Leo shower was evidently pretty much spent—so much so that we did not think it worth while to make a record of what we saw. About as many radiated from near the zenith as from Leo, although the latter group was unmistakably represented."

3. *At Bloomington, Ind.*—On the morning of Monday, Nov. 13th, Prof. Kirkwood alone observed 25 meteors in 20 minutes, between 4h 50m and 5h 10m A. M. Of these 22 seemed to radiate from the vicinity of γ Leonis. "On the evening of the 13th arrangements were made for watching through the night. Prof. T. A. Wylie and myself, assisted by Messrs. J. P. Baker, H. C. Meredith, W. L. Polk, H. V. Ferrell, H. Pope, and W. C. Sandifer, members of the senior and junior classes in the State University, commenced at 8 o'clock, but clouds unfortunately interfered with our observations. From 8 to 9 o'clock however we saw 53 meteors, and from 9 to 10 o'clock 51. At 10 o'clock the heavens had become so nearly overcast that our observations were abandoned."

4. *At Marathon, N. Y.*—Mr. Lewis Swift writes from Marathon, N. Y., on the 13th of November as follows: "From the end of twilight last evening to 10 o'clock I saw no more than are usually visible on clear evenings. I resumed observations again this morning at 5 o'clock and during 45 minutes saw 47 meteors, most of them leaving trains of unusual length and distinctness. The paths of 44 of the meteors if traced backward would meet at a point about R. A. 10h, Dec.+25°. I think the declination of the radiant is now greater than in 1833. An unusual number were visible near the horizon."

5. *At Cleveland, Ohio.*—Mr. W. H. Palmer, Mr. E. A. Palmer, and Mr. C. J. Dockstader counted on the morning of Nov. 14th at Cleveland, Ohio, the following numbers of meteors:

	W. H. Palmer.	C. J. Dockstader.	E. A. Palmer.
From 12^h to 1^h,	18	11	9
" 2 " 3	30	23	23
			Total, 114

The morning was as clear as could be desired, and the meteors were unusually large and brilliant. Many of them left trains.

On the next morning, in the hour between 1 and 2 o'clock, Mr. W. H. Palmer saw 16, and Mr. H. P. Borden saw 23. About half of them seemed to radiate from Leo.

6. It seems from these observations that the number of meteors visible on Monday morning at five o'clock, by a single observer, may be safely called 75 or 80 per hour. Six-sevenths of these were conformable to the radiant in Leo. On the next morning the number per hour if judged by the Cleveland observations between two and three o'clock was 76 for three observers, which is equivalent to about 30 for a single observer. The two hours give an average of about 23 per hour for one person. Not more than half, according to Mr. Marsh, radiated from Leo.

On the next morning the average number seen by each of the twelve observers at New Haven during the three hours after midnight was 13 per hour. Probably less than one-fifth of these belonged to the November group.

It would seem then that we were nearer the node of the orbit of the bodies on Monday morning than on Tuesday morning, and that on Wednesday morning we had passed nearly if not quite through the group. H. A. N.

ART. XI.—*On Molecular Physics;* by Prof. W. A. NORTON.

[Continued from vol. xl, p. 73.]

Terrestrial Magnetism.—In accordance with the ideas already advanced as to the essential nature of electrical excitation (p. 249) we may conceive that the earth may derive its magnetic condition from currents developed in its crust by the impulsive action of the ether of space upon the molecular atmospheres.[1] Both the

[1] As intimated in a former part of this memoir, the priority in the publication of the general theory that the earth derives its magnetic condition from its collision with the ether of space is conceded to Professor Hinrichs, of the Iowa State University, and formerly of Copenhagen. But the idea was no less an original one with the author; and his conception of the essential nature of dynamic electricity, and the magnetic condition of the earth, and his physical theory of terrestrial magnetic phenomena, as resulting from the same supposed original cause, are materially different from the views advanced by Professor Hinrichs. It will be seen also that the theory now presented is but the complement to a previous series of researches upon Terrestrial Magnetism, prosecuted, at intervals, through a period of about twenty years; and a natural offshoot from the theory of Molecular Physics propounded in this paper.

rotatory and orbital motions of the earth may be concerned in the production of such currents. The rotation of the earth should develop currents at each point of its surface, starting in a direction parallel to the equator, and flowing from east to west. Also if we consider the points of the earth lying on or near the meridian whose plane passes through the sun, and designate the velocity of the earth in its orbit by V and that of rotation by v, the absolute velocity of the points in question, will be $V+v$ on the side opposite to the sun, and $V-v$ on the side toward the sun. The current in the former case, due to the velocity $V+v$, will run from east to west; and that in the latter case, due to the velocity $V-v$, will run from west to east. The intensity of the former may be represented by $m(V+v)^2$, and of the latter by $m(V-v)^2$. Taking the difference between these two expressions we obtain as the excess of the intensity of the east and west current over the other, $4mVv$. Such then would be the intensity of the effective current at any point, due to the combination of the velocity of rotation and the velocity in the orbit. At points of the earth's surface, at any moment in the vicinity of the meridian at right angles to that just considered, the currents developed, so far as they originate in the tangential action of the ether, will be wholly due to the earth's rotation. At certain distances from this meridian the component of the orbital velocity, in a direction parallel to the surface, will exceed the velocity of rotation; and the current developed, on the side nearest the sun, will run from west to east. East and west currents will therefore be developed at every place during the greater part of any single day, and the opposite current will originate only during a certain interval of time before and after the middle of the day. Also the east and west current will be more intense than the opposite current developed in corresponding positions. At the close of a day a certain resultant current, for each place, should remain, running from east to west. As the obliquity of the ecliptic to the meridian at the hour of noon, at any place, is continually changing during the year, this resultant current must be continually changing its direction. This change of direction may be represented by supposing the current developed each day to lie in a small circle traced around the point 90° from the ecliptic on the meridian 90° from the station, and that this magnetic pole is carried through the geographical pole in the course of a year. Under this idea each place will have its separate oscillating magnetic pole. At the end of a year these diverse directions of current will also have a resultant; and by considering contiguous places it may be seen that these annual resultants will lie, for a certain district, in parallel small circles, having a common pole. If we confine our attention to points on the equator, and suppose the magnetic proper-

ties of the crust of the earth to be the same at all points, it is plain that every such pole will coincide with the geographical pole; since the annual resultants would be coincident with the equator. But should the conductibility of the earth be unequal in different directions, the final currents developed in such directions should be unequal, and hence the annual resultants should be variously inclined to the equator, and their poles have diverse positions. At points situated without the equator the unequal intensities of the currents, developed at different seasons of the year, will determine at each locality an annual resultant having a certain direction, generally more or less inclined to the equator.

In what precedes we have confined our attention to the action of the ether in directions tangential to the earth. Such currents should be chiefly of the nature of galvanic currents, that is, proceeding from molecule to molecule. Those which result daily from the combined effect of the two motions of the earth will originate in lines parallel to the ecliptic, and follow the directions (or at least in their mean course) of circles traced around the position of the pole above mentioned, on the earth's surface, on the day considered. These may be called ecliptic currents. The currents due to the earth's rotation alone will be of a similar character, and follow circles parallel to the equator. These two sets of currents, especially the former, play the prominent part in originating and maintaining the normal magnetism of the earth, and determining the secular changes that occur in its distribution. The currents resulting from the earth's rotation, can serve only to maintain a uniform normal condition of such currents previously developed. But the ether of space, also impinges normally upon the forward side of the earth. The principal effect of this mode of action, that we have occasion to consider, will be the origination of a series of waves of translation in the sea of electric ether that pervades the interstices of the molecules, spreading out from the most advanced point of the earth. They may be conceived to consist of an endless number of linear currents radiating in great circles from that point. This description of currents exhibit their effects conspicuously in the daily and annual variations of the declination and directive force of the needle. They conspire with the others, and to a certain extent modify them, and originate similar ones.

It should be added that the more permanent magnetic forces developed by the currents above considered may consist, in a great degree, in secondary currents excited within the molecules of the earth. The author's former investigations accord with this view. In a memoir on Terrestrial Magnetism published in this Journal, vol. iv, p. 1, a theory of the magnetic action of the earth was propounded and discussed, based upon the fundamental assumption that "every particle of matter at the earth's

surface, and to a certain depth below the surface, is the center of a magnetic force exerted tangentially to the circumference of every vertical circle that may be conceived to be traced around it." This tangential action, upon the north pole of the needle, was conceived to be directed downward on the north side of the particle, and upward on the south side, (see p. 4 of the paper just referred to). Now if we regard the particles of the earth's crust as so many separate magnets;—magnetized by electric currents, developed as we have been considering,—we are conducted, by an inevitable sequence, to this fundamental basis of the theory in question. For, all such molecular magnets will at each station have their axes perpendicular to the resultant currents traversing that station, to which the magnetization is due. The north end of every such indefinitely small magnet will exert an attractive force upon the north end of the needle, and the south end will exert an equal repulsive force upon the north end of the needle. Since the lines of directions of these forces will not be strictly coincident, their resultant will bisect the outer angle between them, and so be perpendicular to the line proceeding from the center of the molecular magnet. A series of such minute magnets, extending for a small distance will form a magnet of finite length, the entire action of which will be sensibly the sum of the individual actions, and will be perpendicular to the line proceeding from the middle of the magnet. The directive action of the earth will be virtually this.

This being allowed, it follows, as deduced in the former paper, that, except in high latitudes, the needle will be perpendicular to the lines of equal molecular magnetic intensity; also that, the horizontal directive force exerted by the earth will be proportional, or nearly so, at each station, to the molecular magnetic intensity; and the vertical force approximatively proportional to the difference of these intensities on one side and the other of the lines of equal force. It may be added here that the above conception brings our theory into essential correspondence (from the mechanical point of view) with Gauss's; and thus that the conclusions of his memoir become deducible from the present physical theory.

If we conceive the magnetic force of the earth to be wholly due to the *direct* action of the electric currents, circulating from molecule to molecule, the force exerted by each element of the current should be of the same character, and have a similar direction to that in the case just supposed. But, since the resultant currents are shifting their position from year to year, it follows that they may differ somewhat from the lines of equal molecular force. In the sequel we shall, in general, for greater simplicity and distinctness of conception, regard the magnetic action of the earth as due to the primary currents, developed as before ex-

plained. If these give place, either wholly, or in part, to molecular currents, the results will be essentially the same.

Distribution of Terrestrial Magnetism.—The inequality in the distribution of the magnetism of the earth, upon the same parallel of latitude, may be supposed to arise from differences of conductibility in different parts of the earth. It is conceivable that such differences may exist as a consequence of the existence of two great systems of continental elevations; and that the magnetic condition of the earth may be represented by supposing that two sets of currents, originating in these elevations, are superimposed upon those which are due to the undisturbed condition of the crust of the earth. But there is another conception that may be formed of the possible origin of the unequal distribution of the earth's magnetism, which does not involve the supposition of unequal conductibility. It is that the present magnetic state of the earth originated at a remote period in the history of the earth, when it was still in the process of condensation, and its period of rotation was much longer than at present. It will readily be seen that at every epoch, during this transition period, in which the period of rotation was the $\frac{1}{n}$ part of the tropical year, n being an even number, the same region of the earth's surface would, at the close of each successive year, be, for a considerable interval of time, about the autumnal equinox, on the opposite side of the earth from the sun; and thus would come to be traversed by strong currents running from N. of E. to S. of W. (p. 69):—also that at each successive vernal equinox, the same region would be on the side of the earth turned toward the sun, and therefore in the most favorable position for the currents already developed at the autumnal equinox to be reënforced by the new currents.[2] The systems of currents thus originating, at such successive epochs, would not, in general, be coincident; but it will be seen in the sequel (p. 74) that each system should become subject to a motion of revolution, under the operation of the new effective currents annually developed, and that the annual rate of displacement should be different for each system, unless their currents should be of equal intensity, which would be in the highest degree improbable. Now if the shifting movements of the different sets of currents were unequal, the tendency should have been, in the lapse of ages, to bring them all into coincidence, or to consolidate them into one system in each hemisphere. In the light of Gauss's investigations into the magnetic state of the earth, we may conclude that the earth has actually reached this period of its magnetic history.

[2] It is here implied that the more effective currents are developed at the equinoxes; in explanation of this see pp. 69, 72.

At the epochs for which n was an uneven number, two systems of currents should have been developed, one at each equinox, and the intensity of each of these would have been much less than that of the single system (the sum of the two equinoctial systems), answering to the epoch when n was an even number. These separate systems of currents should, therefore, by reason of their secular movements, have tended to become incorporated with the other more effective ones, which would have been displaced more slowly.

It will be seen, in another connection, that the magnetic state of the earth experiences certain changes, from year to year,—in response to the varying magnetic and electric condition of the sun's surface. We may then conclude, from our present point of view, that the existing system of magnetic currents should bear the traces not only of the changes through which the magnetic condition of the earth has passed, but also of the mighty changes that have passed over the face of the sun.

From our present point of view we may discern the probable link of connection between the magnetism and the temperature of the earth. In the paper already referred to (p. 63) a mathematical exposition was given of the formal relations subsisting between the principles of magnetism and heat in the crust of the earth, based upon certain mechanical ideas. We have already seen (p. 64) that the fundamental ideas then assumed are in essential accordance with the present theory of the origin of terrestrial magnetism. It may now be added that the mathematical relations shown to subsist, between the intensity of the magnetic action and the temperature, may be seen to have a physical basis. The dependence here alluded to arises from the fact that the electric currents developed by the impulsive action of the ether of space, within the crust of the earth, must, to a certain extent, pass off in the form of heat; and that the earth may derive a large portion of its heat from this source. Inequalities in the mean temperature of the earth's crust, at equal distances from the equator, should result from inequalities of elevation, &c., and from variations in the intensity of the resultant currents traversing the localities. It will be readily seen that, if the inequalities of the mean temperature of the crust of of the earth resulted entirely from the heat developed by the supposed action of the ether of space, the distribution of the temperature and magnetism would entirely correspond; that the poles of greatest cold would coincide with the magnetic poles, and the thermal equator with the magnetic equator.

Periodical Variations of the Magnetic Elements.—In a paper published in this Journal, vol. xix, p. 183; the author undertook to show that these variations are such as should result from two supposed sets of currents, traversing the photosphere of the

earth, or two corresponding sets of currents traversing the earth's crust. These currents were called, respectively, *radial*, and *ecliptic;* the radial currents radiating from the region of the photosphere most directly exposed to the impulsive action of the sun's rays, and the ecliptic originating on the side of the earth toward the sun, and in directions parallel to the plane of the ecliptic. We have now to observe, (1.) That the ecliptic currents running from east to west, formerly supposed to be developed in the earth's photosphere, have their counterparts in currents running from west to east in the crust of the earth, and developed by the orbital motion of the earth, on the side nearest the sun. (2.) That the orbital motion of the earth develops, within the mass of the earth, currents running from east to west on the side of the earth opposite to the sun. (3.) The impulsive action of the ether upon the forward parts of the earth, as it advances in its orbit, must originate currents radiating from those regions, over the earth; and will especially give rise, in the early morning hours, to currents running toward the north in latitudes lying to the north of the ecliptic, which will deflect the needle toward the east. Strictly, the two sets of ecliptic currents, the one having an easterly and the other a westerly trend, will be developed, at various points on one side and the other of the circle of intersection with the earth of a plane passing through the most advanced point and the geographical pole. The special currents developed on the circle perpendicular to this, will have the greatest intensity on the side opposite to the sun, as already shown. The effects of the diverse currents, originating in the impulsive action of the ether of space upon the preceding half of the earth, are conspicuously observable in the variations of the declination and horizontal force during the last half of the night and the earlier part of the day. As the day advances, the radial photospheric currents (see this Journal, vol. xix, p. 190) come into more effective action, and greatly modify the magnetic variations that would result from the currents just mentioned. They augment the diminution of the horizontal force in the forenoon and deflect the needle farther to the west at midday.[3] They are also the principal cause of the increase of the horizontal force in the afternoon. The change of the hours of the morning maxima and minima with the seasons, is mainly a consequence of the changes experienced during the year, in the position of the circle of the earth, perpendicular to the radius of the earth's orbit at 6 A. M., with respect to a meridian passing through the most advanced point of the earth's surface, at that hour. The circle in question coincides with the meridian at the two equinoxes; is inclined $23\frac{1}{2}°$ to it, on the west side, at the summer

[3] The special effects here alluded to, and in general the effects referred to in what follows, are those observed in our latitudes.

solstice; and under the same angle on the east side at the winter solstice. In consequence of the change of position of this circle the radial currents tend to alter the critical hours above referred to. For the rest it should be observed that the phenomena all show that the temporary currents by which they are produced, do not come into most effective action until a certain interval of time after the moment of most intense excitation; because, doubtless, of the residual currents that continue in action, with diminishing energy.

The two sets of currents, that have been specified, afford a complete explanation of the observed periodical variations of the declination and directive force of the magnetic needle. In considering their separate action it is to be distinctly observed: (1) that the currents produced in the earth's crust by the impulsive action of the ether of space are developed at each station, between the hours of midnight and noon—though the currents thus excited will be propagated on and produce a certain effect at other stations, before midnight and after noon;—(2) that the radial photospheric currents are chiefly effective between the hours of 6 A. M. and 6 P. M.—though their influence extends, especially during the summer, into the earlier and later hours of the night. In their effect upon the declination, the marked tendency of the first set of currents is to deflect the needle toward the east for a certain interval of time before and after 6 A. M., while the conspicuous tendency of the second is to deflect the needle toward the west for a certain interval about the middle of the day. Another effect of the latter set of currents is, when the sun is north of the equator, to augment the morning easterly deflection produced by the former currents. In their effect upon the horizontal force of the needle, the tendency of the radial photospheric currents is to diminish its intensity between midnight and noon, and increase it between noon and midnight; but these effects are especially produced during the forenoon and afternoon. On the other hand, the other set of currents tend especially to augment the horizontal force, during the latter half of the night, and to diminish it during the forenoon. The morning increase of the horizontal force is more conspicuous during the winter than during the summer months, for the reason that the diminishing action of the radial currents in the morning hours, is greater in summer than in winter.

In studying the *Annual Variations*, we must take note of any changes that may occur during the year in the intensity of the two sets of currents by which all the phenomena are conceived to be produced. In fact both sets of currents have varying effective intensities. In these latitudes the radial currents are most effective toward the summer, and least effective toward the winter solstice;—as a natural result of the varying positions of

the point of the earth's photosphere directly underneath the sun.[4] The other set of currents, have a maximum of effective action at the autumnal equinox, and, considered individually, a minimum at the vernal equinox.[5] For at the autumnal equinox the most advanced point of the earth's surface, upon which the impulses of the ether fall normally, will lie $23\frac{1}{2}°$ to the north of the equator; and at the vernal equinox it will lie $23\frac{1}{2}°$ to the south of it. Owing to the annual change in the intensity of the radial currents, the diurnal variations, both of the horizontal force and declination of the needle, that occur during the forenoon and afternoon, are greater in the summer than in the winter. The maximum variations occur after the summer solstice, and the minimum after the winter solstice. By reason of the annual change in the effective action of the other set of currents, the morning variations of the horizontal force and declination (i. e. for a certain interval before and after 6 A. M.) are greater at the autumnal than at the vernal equinox. The more effective action of these currents at the autumnal than at the vernal equinox is conspicuously seen in the higher maximum of the horizontal force at 5 A. M. to 6 A. M., and the lower minimum about 10 A. M. (See Prof. Bache's Discussion of the Magnetic Observations made at Philadelphia, in 1840 to 1845, p. 45.)

We would here call attention to a special fact, from which it results that the currents developed by the ether, both on the side of the earth toward the sun, and on the opposite side, are especially effective about the equinoxes. It is that, for a considerable period before and after these epochs, such currents, excited at any one place, have very nearly the same direction, and so coöperate more effectually. (See additional remark on page 72).

Among the annual variations of declination may be specified an easterly movement of the needle at the hour of 6 A. M. from the winter to the summer solstice. The author has already shown in his previous paper (this Journal, vol. ix, p. 196) that such an effect should result from the action of the radial currents. Another annual variation that has been detected is an augmentation of the mean monthly intensity of the horizontal force, from winter

[4] The precise epoch when the radial currents are most effective should vary with the latitude of the station. It is plain that near the tropic of Cancer it should be some weeks before or after the summer solstice; for at the summer solstice at the hour of noon, the currents, or waves, that reach the station from the different points of the photosphere that receive the sun's rays, should exactly neutralize each other. The epoch, or epochs, in question, it is obvious should approach the summer solstice as we recede from the Torrid Zone. The observations made at Philadelphia on the horizontal force, indicate that the radial currents are most effective in determining the diurnal variation of the horizontal force about a month and a half before and after the summer solstice.

[5] Just as with the radial currents, the epoch of maximum effect, must vary with the latitude, and in the lower latitudes should occur before and after the autumnal equinox.

to summer. (Prof. Bache's Discussion, &c., p. 59). To understand how this may result, it is to be observed, that, since the effective radial currents steadily increase in intensity from winter to summer, and since the action in the afternoon of each day is to augment the horizontal force, and in the forenoon to diminish it, whatever effective residual current may remain, as the result of the entire action of the currents in question during a single day, must have the direction of the currents that augment the force. By the continual accumulation of such residual currents, there must accordingly be a tendency to an increase in the intensity of the horizontal force from winter to summer.

But the other system of radial currents should also coöperate with these in producing variations in the intensity of the horizontal force, from one month to another. Since the effective action of these increases, as we have seen, from the vernal to the autumnal equinox, and an action to augment the horizontal force, each day, is followed by one to diminish it, the tendency of the daily accumulation of residual currents should be to diminish its mean daily value, from the vernal to the autumnal equinox. Such a tendency does in fact manifest itself. As the result of the observations at Philadelphia, already referred to, the mean monthly value of the horizontal force was 0·0018 of its absolute value less in September than in March.[6]

In the former memoir it was maintained that the *Irregular Disturbances* of the magnetic needle might be satisfactorily explained if we admit the existence of occasional photospheric currents proceeding from various points over the preceding and following hemispheres of the earth, and that the ordinary region of maximum excitation lies in the plane of the ecliptic, from 60° to 90° to the west of the point of the earth's surface that has the sun in the zenith; and that the region diametrically opposite to this is a secondary region of special excitation. In special instances the point of maximum excitation may have other posi-

[6] There are still other operative causes that tend to produce annual variations of horizontal force; viz., all the changes that occur annually in the effective action of the ecliptic currents, whether developed in the crust of the earth or its photosphere. The general causes of change are: (1), a variation in the velocity of the earth in its orbit; (2), a variation in the direction of the currents excited; (3), a change in the extent of the portion of each parallel of latitude that is exposed to the impinging action of the ether, or auroral matter; (4), *a change in the direction of the progressive motion of the solar system, as compared with the direction of the orbital motion of the earth.* The epochs of maximum and minimum, dependent upon the first cause, should fall near the solstices; and those dependent upon the third and fourth causes should fall near the equinoxes. The effects of the second cause will vary with the locality. *The currents due to the general motion of the solar system are most intense just before the vernal equinox, and least intense just before the autumnal equinox.*

The conjoint action of the two systems of currents, that have been under consideration, in determining the annual variations, might be strikingly exemplified by considering those which occur at the intertropical station of St. Helena.

tions nearer the meridian in which the sun lies. An adequate cause for such occasional currents may be found if we conceive that they result from the penetration from time to time into the earth's photosphere of bodies of auroral or vaporous matter, expelled from the sun, and arriving with absolute velocities, ordinarily less than that of the earth in its orbit. The photospheric currents, may be conceived to result either directly from the impact of the auroral matter, or indirectly from electric discharges at special localities within the photosphere, consequent upon the reception and distribution of such bodies of matter.

This conception of the origin of the irregular disturbances links them theoretically, as they are in fact, on one side with the physical changes observed in the photosphere of the sun, and on the other with the auroral phenomena that occur in the photosphere of the earth. It contemplates the coruscations of the aurora and the sympathetic tremblings of the magnetic needle, as but one phase of the "magnetic storm" of subtile vapor that descends upon the earth from the regions of space.

One of the most conspicuous facts relative to the disturbances under consideration is that the disturbances of the horizontal force that diminish its intensity prevail at all hours over those which augment it. This fact may be attributed, from our present stand-point, to the circumstance that the descending masses of auroral matter, in receiving the velocity of rotation of the photosphere of the earth, must generate electric currents, or progressive waves, directed toward the west. There is still another effect that theoretically should result from the arrival of these cosmical masses. The electrical excitation that should thereby be produced in the photosphere will act indirectly, in a greater or less degree, upon the earth's surface, and develop currents running over it in every direction from the locality immediately underneath the region of excitation in the upper atmosphere. The increase in the morning maximum of horizontal force, in the years of greatest disturbance, gives indication of the existence of this effect. The tendency of such currents will be almost identically the same with the currents we have supposed to be directly developed in the earth's crust by the impact of the ether of space.

The electrical action upon the crust of the earth here considered may be in a great degree direct rather than inductive. That is, the penetration of the subtile cosmical matter into the earth's photosphere may occasion streams of electricity in the direction of the impact, that may penetrate the atmosphere and take effect upon the earth's surface. The physical cause here supposed to be in operation should coöperate with the others that have been noticed in determining regular variations of the declination and directive force, that would be observable in the mean daily variations, for a month, or a year, even after these have been freed from the greater disturbances.

It is conceivable that the effects which have been ascribed to the radial photospheric currents might be produced by an analogous system of currents within the earth's crust, directed toward the region directly underneath the sun. But no plausible cause can be assigned for the existence of such currents; since if the sun be supposed to produce tides in the vast sea of electric ether that pervades the earth's crust, and thus originate the currents supposed, the consequent effects upon the declination and horizontal force should be of the same character, if not of equal amount, at midnight and at noon. Besides the moon, by this sort of action, should produce greater effects than the sun. The moon, as a matter of fact, does exercise a disturbing action upon the magnetic needle, but the perturbations produced by it have only been detected by the closest scrutiny.

We may here take occasion to remark that the lunar diurnal variations of the declination, and of the horizontal force, are, in their nature, such, as should result from a tidal action of the moon upon the terrestrial sea of electric ether. Thus there should be, theoretically, a maximum of west declination at the upper culmination, or thereabout, and another maximum at the lower culmination. There should also be a maximum of horizontal force a few hours after each culmination, and a minimum a few hours before each culmination. For, the rise and fall of the electrical tide should be attended with currents, or rather waves of translation, setting from all directions toward the point underneath the moon, or a point somewhat in advance of this; and also toward the diametrically opposite point.

Secular Variations.—The secular changes experienced by the declination and directive force of the needle appear to be *the natural consequence of the continual operation of the physical process by which the earth was originally magnetized.* It will be recollected that this consists principally in the development of ecliptic currents on the side of the earth farthest from the sun, which have a greater intensity than the oppositely directed currents developed on the side toward the sun; also that these preponderating currents which originated at any station, at the solstices, run from E. to W., while those developed at the vernal equinox proceed from S. of E. to N. of W., and those developed at the autumnal equinox from N. of E. to S. of W. It is also to be observed that, *in the Northern Hemisphere, the currents which originate at the autumnal equinox exceed in intensity, or quantity, those which originate at the vernal equinox;* for the reason that a greater portion of each northern parallel of latitude is exposed to the impulsive action of the ether. Now conceive all the currents in question that originate during the year, at any station, to be decomposed into two, one running from E. to W., and the other from S. to N. or from N. to S. It will be seen that the

annual resultant of the one set of components will constitute a current from E. to W., which will be equal to the sum of the individual components; while that of the other set will be equal to the excess of the currents that run from N. to S. over those that run from S. to N. These general facts being borne in mind it may be seen that the secular variations of the declination result from the combined operation of two causes, viz:

(1.) The prevailing annual action of the resultant E. and W. current, or of the resultant N. and S. current, according to the declination of the needle; except when the declination is easterly, when the two currents will coöperate.

(2.) The varying action of the impulses proceeding from the resultants of the new currents and those previously existing, shifting and changing in intensity from year to year, which run through all the places that lie on the east and west sides of the magnetic meridian of the station.

Let us conceive the diverse directions of the needle on different meridians to be represented by a sinuous curve, alternately concave and convex toward the north, to which the needle is perpendicular; a certain point of the concave portion being on the meridian of Philadelphia, and a point of the convex portion on the meridian of London. Now confining our attention to the first operative cause, on the concave part where the declination (E. or W.) is small it is plain that the N. and S. current should prevail, and therefore the needle have an annual westerly movement. But at a point of the ascending curve where the declination (W.) is large, the other current should prevail, and the needle turn toward the east. Both of these cases are represented by the present secular variations at Philadelphia and London. On the higher part of the curve, where the declination (E. or W.) is small, the N. and S. current should prevail again, and the needle be deflected toward the west. The neutral, or transition points in the curve, should fall at about equal distances on opposite sides of the point of maximum declination (W.).

If we follow the curve ascending toward the west, from the line of no declination on this continent, both sets of currents will coöperate, and the needle should turn toward the west, as it now does throughout the United States. It appears then, that throughout Western Europe and the United States the actual progressive movements of the needle are precisely those which should result from the operation of the first cause above mentioned; that is, from the direct action of the new currents developed at the station of the needle.

To understand how an alternation of movement may occur at a given station, we must consider the probable and possible effects of the other general cause. Under the operation of the first cause the present westerly movement, at Philadelphia,

should continue until Philadelphia has magnetically the position of the more westerly of the two neutral points above mentioned. But the needle will not in fact remain stationary when this position has been reached; this could not be the case unless the effects of the varying resultants of the new and old currents should exactly counterbalance each other. In reality, those on the east side should preponderate over those on the west side because they will be more displaced, and the currents of impulses proceeding from the same number of points will correspond more nearly in direction on the east than on the west side. The tendency of the second general cause should then be, to give the needle at Philadelphia a motion toward the east, in the magnetic position in which it would otherwise remain stationary.

If we now revert to London, as a type-station for Western Europe, the present easterly movement of the needle should continue until the magnetic position of the more easterly of the two neutral points, so called, is reached. But at this position the resultant currents at places lying to the west, should, in the existing condition of the currents of the eastern continent, preponderate over those lying to the east, and the easterly movement should therefore continue. The continued operation of the second general cause may thus keep up an easterly movement until the needle attains to a certain easterly declination. But the direct tendency to a westerly movement that increases as the easterly declination becomes greater, must ultimately prevail, and the needle begin to turn toward the west.

It is obvious that the general result is the same as if the whole system of currents were gradually transferred to the west; or the representative sinuous curve had such a motion,—its folds at the same time changing more or less. Or rather, to obtain a comprehensive view of the entire process, we should conceive of a system of such representative curves, traversing the earth's surface, at various distances from the equator, and suppose the whole system to be carried bodily toward the west.

To explain completely the secular variations, especially of the *horizontal force*, we must take into account another cause in operation, not yet mentioned. It is that the resultant currents, at any station, may either be increasing or decreasing in intensity from year to year; for the reason that the annual diminution of intensity of currents already existing may be over-compensated by the new currents, or the reverse.[6] During the period of over-compensation, or of increasing intensity, the period of the secular change of declination should increase, and decrease in the

[6] A tendency to a diminution of the horizontal force may arise from two causes, viz: a gradual decline of existing currents, and an increase in the ecliptic photospheric currents developed by the impact of the auroral matter received from the sun.

succeeding period. Since it appears from Mr. Schott's discussion of the secular variations (see Report of Coast Survey for 1855, p. 337), that the secular period is shortening on the western coast of the Atlantic, we have to infer that we are at present in that magnetic phase in which the reinforcement of intensity, from the new currents, is less than the annual diminution. In this circumstance we have the probable explanation of the annual diminution of the horizontal force in the United States and Canada. An increase of the photospheric currents may coöperate.

Another general principle should be had distinctly in mind, in this connection; it is that the action of the auroral matter received from the sun, upon the photosphere of the earth, develops there a system of currents, the tendency of which should be the reverse of that of the corresponding system continually developed in the crust of the earth, by the ether of space. The relative direction in which the solar matter approaches the earth, is also approximately the same as that of the impulsive action of the ether; only that in proportion as the velocity of recess from the sun, is greater, the direction of approach is displaced toward the sun. As already intimated, the impinging solar matter, also develops radial currents, by direct action propagated to the crust of the earth. This effect we have recognized in the partial dependence of the morning variation of the declination, and of the horizontal force, upon the eleven-year period of the sun's spots. It is also strikingly manifest in determining the principal deflections of the needle during an Aurora Borealis; at the same time that the ecliptic and equatorial currents, from E. to W., developed in the photosphere, have the effect to diminish the horizontal force. This supposed action of the solar matter upon the crust of the earth may arise either from the direct propagation of the impulses, as already intimated; or more probably from an increase in the density of the ether, resulting from the acceleration of the fall of the matter in question, produced by the earth's attraction.

The secular variations should also be dependent, in some degree, upon the electric currents due to the solar matter. In fact there is abundant evidence of such dependence. The annual rates of variation of all the magnetic elements, vary during the eleven-year period as they should do upon this supposition. Thus the tendency to a westerly deflection of the needle, and to a diminution of the horizontal and vertical forces, is least in the year of minimum spots and magnetic disturbances. It is interesting to observe, in the Philadelphia Observations, how manifestly this minimum tendency existed in the case of each of the three elements, in the years 1842, and 1843. Another evidence of the dependence in question is afforded by the fact that the annual rate of the secular variation of declination, in this country,

reached its maximum about the year 1855; and that this is near the maximum epoch of the secular period of the sun's spots. In Europe the tendency of the same general cause is to make the secular rate the least at the same epoch. In this way, probably, it has happened that the increasing secular rate of the easterly movement there has become nearly constant.[7]

Observation has furnished the means of testing the explanation we have given of the progressive change of declination. Dr. Loyd, in his discussion of the Dublin Observations (between 1840 and 1843), has established that the needle at Dublin has, from the vernal equinox until after the summer solstice, a motion in a direction opposite to the annual progression, and a motion in the other direction from the autumnal to the vernal equinox. The discussions of the observations at Philadelphia, and Toronto, have revealed a similar law at those stations, though the direction of the annual progression is reversed. Now, at Dublin the new currents developed at all seasons tend to give

[7] From our present stand-point we may obtain a distinct view of the origin of the diverse luminous phenomena of the Aurora Borealis, as well as of the attendant magnetic phenomena. We may perceive that the Aurora is a combined magneto-electric and electro-magnetic phenomenon:—that the auroral light results from electric discharges along the lines of magnetic polarization that traverse the masses of solar matter, while passing over from the preceding to the following side of the earth's photosphere: that the discharges are in a great degree due to the demagnetizing action of the electric currents developed by the solar matter impinging upon the preceding side of the photosphere; but in part also to a direct disturbance of the electric equilibrium, along the lines of polarization, by these currents, or by the free electricity in the photosphere. We here allude, especially, to the more conspicuous auroras. It is conceivable that should there be an intermission in the reception of auroral matter from the sun, or the supply feeble, the currents continually excited in the earth's crust by the ether of space, may by augmenting the intensity of the earth's magnetism, originate currents in the photosphere, directed upward instead of downward. Such effects should be especially observable in the regions of greatest directive force. It is to be observed that the tendency of the demagnetizing action accompanying the more conspicuous auroras, with the attendant electric currents, is to disperse the auroral matter, and in this way to occasion its expulsion to an indefinite distance, under the operation of the repulsive force of the earth exerted upon single molecules, or minutely divided masses (see this Journal, vol. xxxviii, p. 70. The decrease of the earth's magnetizing action coöperates in this.

There are several important probable inferences that may be drawn from the preceding discussion, which it may be advisable to state here, very briefly.

1. The sun must have become magnetized after the same manner as the earth, by reason of its rotation, and of its motion of rotation combined with its progressive motion through space. As in the case of the earth, there must be a continual development of new currents, tending to exalt its magnetic state. These new currents by this mode of action should condense the auroral matter of the photosphere, along the lines of polarization, and so develop both light and heat. The spots on the sun are probably due to an inverse effect (that is, demagnetizing and dispersing), produced by the electric currents directly developed in the photosphere, by the descent into it of cosmical matter, as the sun moves forward in space. According to this the faculæ and accompanying dark spots, have a similar origin to terrestrial auroras. Upon this theory the dark spots should be wanting at the magnetic equator, and at the poles. They should also be mostly confined to low latitudes (heliographical).

It is probable that a large fraction of the heat by which the temperature of the body of the sun is maintained is the result of the continual recurrence of the pro-

the needle an easterly deflection; except near the autumnal equinox when their effect upon the declination will be slight. For the currents will run from S. of the magnetic E. to N. of the magnetic W., except at the autumnal equinox when they will be nearly perpendicular to the needle. In the annual inequality, therefore, the needle should be in its most easterly position at the vernal equinox, when the currents will be most oblique to the needle, and at its most westerly position toward the autumnal equinox. At Philadelphia and Toronto the secular change is due to the excess of the N. to S. currents, from the summer to the winter solstice, over the S. to N. currents from the winter to the summer solstice. Under the influence of these currents the needle should be in its most westerly position near the winter solstice, or near the close of the period during which the N. to S. currents are developed; and at its most easterly position near the summer solstice. The observations at these stations give results in entire accordance with these theoretical conclusions. But for the influence of the currents at other localities the amount of the inequality should be equal to the annual secular change. This was the case at Toronto (each 2′, in the

cess of magnetization by the impinging action of the ether of space (p. 66). The penetration of cosmical matter into the photosphere is another source of heat.

2. Similar inferences may be drawn with respect to the magnetic and thermal condition of the planets; and an approximate estimate may be made of the comparative condition of the different bodies of the solar system.

3. The continual development of heat in the entire mass of the earth, by the action of the ether, is probably the origin of those subterranean Titanic forces, which have so repeatedly, in past geological ages, fractured and upheaved certain portions of the earth's crust; and whose effects are now observable in earthquakes and volcanic eruptions. Upon this idea there should probably be certain lines of upheaval corresponding to the magnetic currents, in some of their shifting and comparatively stationary positions.

4. The rotating and revolving nucleus of a comet should become magnetized and heated in the same manner as the earth, and the sun, both in its mass and photosphere. In this fact we have the apparent origin of the formation and detachment of successive nebulous envelops, and of the emission of luminous jets from the nucleus;—the process of detachment and indefinite expulsion being the same as already alluded to, as in operation in the photosphere of the earth (p. 76). The same process attends the formation of the solar spots, and originates streams of nebulous matter, seen in the zodiacal light. The residual cometary phenomena, which remain unaccounted for by Olbers and Bessel's theory, as applied and amplified by the author (see this Journal, vols. xxvii, xxix, and xxxii, [2]) may be understood, in their minute details, in the light of the present conception.

5. It may be added, in confirmation of the theory of the continual descent of auroral matter, derived from the sun, into the earth's photosphere, that the diurnal variations of the electric tension near the earth's surface, are in accordance with the idea that free atmospheric electricity, for which no adequate terrestrial cause has yet been ascertained, is derived from the auroral matter thus received. Also, the diurnal variations of the barometer are other observed effects that should result, on mechanical principles, from the same general cause.

Again, the diminution in the hourly fall of the temperature, during the latter part of the night, for which no sufficient meteorological cause can be found, would seem to afford direct evidence of the heating effect that has been attributed to the resisting impulses received from the ether of space.

years from 1845 to 1851). At Philadelphia the annual progression, in 1843, was (4′·4); more than double the annual inequality (2′). This must be attributed to the preponderating action of the currents traversing those localities at which the needle was turning toward the west.

Unequal Magnetic Intensities of the two Hemispheres.—This has its origin in the *unequal absolute velocities of the earth, near the equinoxes, resulting from the progressive motion of the solar system.* A calculation from the most reliable data gives for the ratio of the maximum velocity (March 4,) to the minimum velocity (Sept. 6), 1·29. Now the ver. equi. currents determine the magnetic intensity of the southern hemisphere, in high latitudes, and the aut. equi. currents that of the northern hemisphere; and the ratio of intensities at the poles (dip 90°) should be nearly equal to that of the max. and min. velocities (1·29). According to Gauss's charts, its actual value is 1·32.[a]

[To be concluded.]

ART. XII.—*The Distribution and Migrations of North American Birds;* by SPENCER F. BAIRD, Asst. Sec. Smithsonian Institution. (Abstract of a memoir presented to the National Academy of Sciences, Jan., 1865.)

IT is well known to all students of Natural History, that the zoology of America or the new world is very different from that of the old world, and that with these two grand divisions, there are in each various subdivisions of greater or less importance. To Dr. Sclater[1] is perhaps due the merit of having been the first clearly to define the "Regions" into which the animal life of the terrestial globe, the birds especially, may be divided, and to point out approximately their relative magnitude and boundaries as well as their comparative richness in species of birds. Some of his details have been corrected and improved by Mr. Wallace,[2] but the conclusions of Dr. Sclater are in the main those which have received the support of most naturalists of the present day, and his details will ever mark an era in the science of zoölogical geography.

Dr. Sclater, in the article above alluded to, presents the follow-

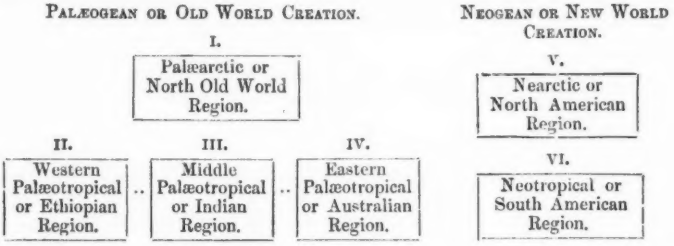
[a] It should have been stated in the text (p. 67) that the rotation of the earth virtually shifts the point of normal impact of the ether to the east of the 6 A. M. meridian; and so delays the morning critical hours.

We propose to discuss, very briefly, in the next No. of this Journal the remaining topic of our memoir,—Chemical Action.

[1] Journal of proceedings of the Linnæan Society: Zoology, ii, 1858, 130. (Read June 16, 1857.)

[2] Ibis, 1859.

ing scheme of the arrangement of "regions" as best illustrating their relationship.



The boundaries of these regions, as defined by Dr. Sclater with Mr. Wallace's corrections embrace the following countries.

I. *Palæarctic Region.*—All Europe and Africa north of the Sahara, and all continental Asia north of about the parallel of 30° N. lat. including the whole mountainous country and plateaus of Central Asia, as well as Japan and the Kuriles. The Aleutians, assigned by Dr. Sclater to this region, appear to belong more to North America.

II. *Ethiopian Region.*—This embraces all of Africa south of the Sahara, and on the eastern side all south of about 30° N. lat., as well as most of Arabia, except the portion along the Indian ocean and the Persian gulf. It includes also Madagascar, and the adjacent islands as Mauritius, Bourbon, etc. The Sahara Mr. Wallace considers as belonging to neither the Palæarctic nor the African region, but to occupy the position of a sea, and to be essentially destitute of land species.

III. *The Indian Region.*—This includes the low lands of continental Asia, about south of 30° N. lat. and the portion of Arabia excluded from the Ethiopian region, as well as Ceylon, Sumatra, Java, Borneo, and the Philippines. It is the country washed by the Arabian Sea, the Persian Gulf and the China Seas, and its southeastern limit passes between the islands of Bali and Lombok, between Borneo and Celebes, and between the Philippines and the Moluccas.

IV. *The Australian Region.*—This includes Australia, New Guinea, Tasmania, New Zealand and Polynesia, also Lombok, Celebes, the Moluccas, and the Sandwich Islands. Mr. Wallace calls attention to the fact of the very great dissimilarity between the faunæ of Bali and Lombok, and of Borneo and Celebes, although geographically very near each other, while islands of the Indian region, as well as of the Australian, are respectively very closely allied, although much more remote from each other than those just contrasted. The explanation of this difference he finds in the comparatively slight depth of

water between islands of the same region, while the channel separating those of the different regions is almost unfathomable. By an elevation of 50 fathoms, all these islands of one region would almost become joined to the main land of their respective regions, while the channel separating the latter would still constitute a physical barrier. Hence he infers that subsequent to the original peopling of the Indian and Australian regions, a subsidence into the sea and the consequent production of islands, while it ultimately modified the minor characters of the faunæ, left the broad outlines unchanged.

V. *North American Region.*—Dr. Sclater divides this from the South American somewhere in Mexico, the line reaching farther north on the coast, and more to the south in the central mountainous portion. Wallace draws the line about the parallel of 22°, or near the Tropic of Cancer. To the north it includes Greenland.

VI. *South American Region.*—This embraces, according to Sclater and Wallace, the rest of continental America, the West Indies, the Galapagos, the Falklands, etc., while Wallace even includes (very erroneously, however,) the Sandwich Islands.

Of the regions thus sketched out, I propose to confine myself to the two last mentioned, or those of the new world, and more especially the portion included in the United States and north of it, and to point out the minor subdivisions and peculiarities of the ornithological faunæ of the same. Before proceeding however to this subject, I may premise that I cannot quite agree with Dr. Sclater in referring the West Indies to the South American Region, but prefer to consider it as having independent rank as:

VII. *West Indian Region.*—In winter a large proportion of the inhabitants of the islands are visitors from North America, but the summer fauna is very distinct. The islands nearest to North and South America have of course an impress of the characteristics of these continental areas respectively, but as a general law it may be stated that of the species of land birds peculiar to the West Indies, exclusive of the diurnal Raptores and Columbidæ, a large proportion belong to genera found equally in North and South America, as *Vireo*, *Turdus*, *Mimus*, *Polioptila*, *Dendroica*, *Tyrannus*, *Myiarchus*, *Contopus*, *Myiadestes*, *Progne*, *Petrochelidon*, *Icterus*, *Sturnella*, *Colaptes*, etc.: an almost equal proportion belong to genera peculiar to the West Indies, and characterizing several islands, as *Gymnoglaux*, *Mimocichla*, *Spindalis*, *Phonipara*, *Tachornis*, *Loxigilla*, *Saurothera*, *Blacicus*, *Todus*,[1] etc. or else more or less peculiar to one island respectively as *Teretristis*, *Melopyrrha*, etc., to Cuba, *Siphonorhis*, *Polytmus*, *Glossiptila*, *Hyetornis*, *Laletes*, etc., to Jamaica, *Dulus*, etc., to

[1] *Todus Mexicanus* of Lesson is a Porto-Rican species.

Hayti. Where the species belong to continental genera not represented in North America, they are more generally of Mexican and Central American forms and rarely of strictly South American.

The following table of resident land birds of Cuba and Jamaica, exclusive of diurnal Raptores and Columbidæ, although approximately complete only, may serve to illustrate more fully the preceding remarks.

	Cuba.	Jamaica.
South American genera,	..	1[4]
Central American and Mexican,	..	1[5]
South and Central American,	2	3
North and Central American,	5	2
North, Central and South American,	16	10
West Indian,	8	6
Peculiar to the Island,	3	6
Total,	34	29

The species of truly West Indian birds are remarkable for their local distribution, comparatively few being found on more than one of the larger islands, and, what is still more remarkable when the contrary is the case, an intervening island may be destitute of the species. Thus Cuba lacks several species common to the Bahamas and to Jamaica.

Professor Agassiz (Types of Mankind, 1854), has urged very strongly the recognition of an Arctic and an Antarctic region or "realm," a point in favor of which there is much to be said, but which cannot be discussed in the present article. He also anticipates Dr. Sclater in regard to some of his views, but the facts at command at the time did not allow him to define the boundary lines of the regions with the same precision. Still more recently Dr. Pelzeln (Reise der Novara, 1865) insists likewise upon an Antarctic region.

Proceeding now to the especial subject of the present article, the mapping out of North America with reference to the geographical distribution and migrations of North American birds, it may be premised that in the article above referred to by Professor Agassiz, in Nott & Gliddon's Types of Mankind, we find the first attempt to mark off the zoological provinces of the New World—and very successful considering the insufficient data accessible at the time. In 1859[6] Dr. Leconte sketched out their

[4] Nyctibius. [5] Phonipara.

[6] Coleoptera of Kansas and New Mexico, Dec. 1859, Smithsonian Contributions, vol. xi.

I may also refer to incidental mention of the same law in a paper by myself on the birds of Cape St. Lucas, in the Proceedings of the Philad. Academy for Nov. 8th, 1859, p. 299.

boundaries, in North America, with more precision, having particular reference to the distribution of Coleopterous insects.

The subdivisions by Dr. Leconte of these provinces, as based on the study of their Coleoptera, do not agree strictly with those of the ornithological faunæ, especially in the considerable number of local areas which he has adopted. This difference is, however, easily intelligible when we bear in mind the much superior power of flight and innate tendency to migration of the bird as compared with the insect; the distribution of reptiles agreeing much better with his outline than that of birds.

To present the general principles of distribution to which I have been led by an examination of the large collection of specimens in the museum of the Smithsonian Institution, I may say that as far as its ornithology, and to a considerable degree its vertebrate zoology in general is concerned, North America appears to be divided into two great regions, an eastern and a western, which in the United States are of approximately equal extent, but very unequal farther north. The eastern division extends from the Atlantic seaboard, westward across the Alleghanies (which affect the distribution of species but little) and over the valley of the Mississippi and its fertile prairies to about the 100th degree of longitude, or to the beginning of the sterile plains. Its western border is not sharply defined, nor strictly in a meridian line, but somewhat oblique, and interdigitates with the western division by extending westward along the river bottoms, some species, as *Galeoscoptes Carolinensis*, *Vireo olivaceus*, &c. occurring as far west as Fort Benton, or even Fort Colville.

The western division begins at the western border of the eastern, or along the sterile plains of the trans-Mississippi country and extends across to the Pacific ocean. The character of the ornithological fauna of this division is much the same through and beyond the Rocky Mountains to the eastern slope of the Sierra Nevada and Cascade Mountains of California and Oregon, but changes somewhat on the western slope and thence to the Pacific, and although to a considerable extent uniform, yet exhibits some modifications which may warrant a separation into a western and middle division, making three in all, which we may call provinces, of very unequal extent, and exhibiting further modifications or subdivisions with latitude, as I shall proceed to explain, taking into consideration the whole continent north of Mexico.

As previously remarked, the eastern province or division extends from the Atlantic ocean to about the meridian of 100° west from Greenwich, or 23° west from Washington. The line of division on the Gulf of Mexico, starts near the eastern border of Texas, perhaps between the Brazos and the Sabine, and fol-

lowing up the direction of the former river to the approaches of the Great Desert nearly on the meridian mentioned, proceeds northward, forced sometimes more or less westward, especially along the Platte, sometimes eastward. It crosses the Platte between Forts Kearney and Laramie and intersects the Missouri between Fort Randall and Fort Pierre, perhaps near Fort Lookout, as it is between the first mentioned two points that in ascending the river we find the change to take place in the ornithology of the country. Soon after crossing the northern boundary of the United States and to the western side of Lake Winnipeg, the line rapidly inclines westward, especially beyond the Saskatchewan, and extends to the Rocky Mountains, including the valleys of Athabasca and Great Slave Lakes, and both sides of the Mackenzie River, north to the Arctic ocean, even crossing the Rocky Mountains to the Porcupine river and into Russian America at least to 145°, or beyond the forks of the Yukon, where Mr. Kennicott found many of the most characteristic summer land birds to be almost identical with those of Slave Lake, Lake Winnipeg, and Northern Canada.

The western province occupies the western slope of the Cascade and Sierra Nevada ranges of mountains in the United States, although its extent southward along the peninsula of Lower California is not well determined. To the northwest it extends at least to the 140th meridian, beyond that probably replaced by a more Arctic fauna. We are not sufficiently familiar with the birds occurring between the northern Rocky Mountains and the coast, to tell how far inland in Stickin Territory or even in northern British Columbia, the coast fauna extends, perhaps not farther than in California or Oregon, although it is possible that, owing to the absence of a continuous longitudinal range of great height, the western and middle regions may there be more thoroughly blended into one.

The middle province, or that of the great plateau, occupies the space between the two just mentioned, probably not passing in its integrity, or as a peculiar province north of the valley of the Saskatchewan and is thus wedged in between the two. As already stated, it extends along the eastern slope of the Cascade and Sierra Nevada mountains, and apparently along the east side of Lower California to Cape St. Lucas, at least the birds of the Cape, as will hereafter be explained, belong much more emphatically to it than to the Western province. A break in the mountains opposite San Diego explains the appearance at that point on the coast of a few species like *Tyrannus vociferans*, *Sialia arctica*, *Polioptila melanura*, &c., so characteristic of the middle province. The southern boundary of this province during the summer may be considered as occupying the valleys of the Rio Grande and Gila but along this line it is greatly mixed up with

the peculiar fauna of Northern Mexico, which as far as its summer birds indicate, is almost entitled to be considered as a fourth main province.

The eastern province to the north merges into the Arctic, and southward exhibits a very important subdivision in the hot region of the south Atlantic and Gulf States, which is bounded to the north by the isothermal of 80°, extending however up the coast to the Dismal Swamp of Virginia, or even to the James river. To the west it ranges along the isothermal of 83° or 85° following the line to the N.N.W. along the valleys of the Brazos, Red river, the Washita and the Canadian. Most of the species belonging to this subdivison reach along the valley of the Mississippi to a point far north of their limit on the Atlantic slope; the Swallow-tailed-Hawk, Parakeet, and other characteristic species, being well known visitors to Cairo, St. Louis, and even as far north as Wisconsin. This subdivision of the eastern province experiences a still further modification in the southern part of Florida in consequence of the proximity of the Bahamas and Cuba, which causes stragglers of the West India fauna to enter its limits, especially along the south eastern keys. Some of these are *Certhiola Bahamensis*, *Progne cryptoleuca?* *Vireo barbatula*, *Quiscalus aglaeus* (*Q. baritus*, Baird, B. N. A., 556), etc. The only really peculiar indigenous land bird in Florida is the Florida Jay (*Cyanocitta Floridana*), seldom, if ever, found out of that State. As far as is known, there is no corresponding southern subdivision on the west coast in the western province, although California and Washington Territory have each some peculiar species.

As in the eastern province, so in the middle, there is a subdivision along the southern border inhabited by species belonging more particularly to northern Mexico, and occupying the valleys of the Rio Grande and Gila, extending northward along the Rio Grande and Colorado far into the United States. It is the species of this subdivision, that, with those peculiar to Cape St. Lucas, characterize the summer fauna of the latter region. In winter, both there and along the Mexican boundary line, these species are mingled with others coming from the more northern portions of the middle province.

In addition, however, to possessing certain species of the boundary line fauna, Cape St. Lucas has other peculiarities which entitle it to especial consideration.[7]

It forms a distinct subdivision of the boundary sub-province even more peculiar in its relations than Florida, where the characteristic species (excepting the Florida Jay) are stragglers of the West Indian type from the Bahamas, while as shown by the

[7] See Baird, Pr. Acad. Nat. Sci., Nov. 8th, 1859.

indefatigable researches of Mr. Xantus,[8] there are at least twenty species found at Cape St. Lucas not known elsewhere.

Very few of the birds of the coast of California, or of the western province, winter at Cape St. Lucas, the species being almost entirely those of the middle province. The new and peculiar species in all cases belong to genera of the middle province, especially of its boundary subdivision, and no genera are peculiar to it. Furthermore, in no instance do we find species of the *Tierra Caliente* of Mexico not belonging to the United States, nor of any Mexican genera that do not possess representatives in the United States. The difference between the species of birds of Cape St. Lucas and of Mazatlan is very great, although separated only by the breadth of the Gulf of California.

From all these considerations we are legitimately entitled to claim Lower California, or at least its southern extremity, as belonging to temperate North America, even more positively than Florida itself.

Peculiarities in regard to the size of Cape St. Lucas birds will hereafter be referred to.

There is of course an Arctic province which melts gradually into those great provinces mentioned, and along the mountainous ranges extending far southward, in fact almost into Mexico, as shown by the occurrence in summer at Cantonment Burgwyn, near Lat. 37°, of *Lagopus leucurus*, *Pinicola Canadensis*, *Curvirostra Americana*, *Hesperiphona vespertina*, etc., while the two last mentioned species, with *Carpodacas cassini*, are even found in summer on the highlands about Orizaba, as shown by specimens transmitted to the Smithsonian Institution by Dr. Sartorius. Similar intrusions of species belonging to the North Mexican fauna take place up the valleys of the Colorado and the Rio Grande, and of those of the eastern province westward along the Missouri and along the Canadian, etc., but they do not affect the general plan. Although characteristic of the eastern province, as already stated, the Cat-bird, (*Galeoscoptes Carolinensis*), Red-eyed Vireo (*V. olivaceus*), and Wild-pigeon (*Ectopistes migratoria*), are found along the northern boundary of the United States to the Cascade Mountains, while specimens of *Dendroica coronata* have even been taken at Fort Steilacoom on Puget Sound. On the other hand, *Turdus nævius*[9] has been shot on Long Island and in New Jersey, *Helminthophaga celata* in the Atlantic states, and *Zonotrichia Gambelli*, and *Spizella pallida*,

[8] See Xantus, Pr. A. N. S., Nov. 1859.

[9] I am informed by Dr. Cabot that a third specimen has recently (Dec. 1864) been shot near Boston and presented to the Natural History Society. As it has been met with as far east as Fort Franklin, it may not improbably reach our eastern coast in company with some of our eastern species bred in the Mackenzie River valley and returning southward to the Atlantic.

are well known and constant visitors in the region of the Great Slave Lake.

Several species of water birds that belong to the winter fauna of the Pacific coast resort to the Slave Lake region and north of it to breed, crossing the Rocky Mountains for the purpose. Among them may be mentioned *Larus Californicus* and *brachyrhynchus*, *Colymbus Pacificus*, *Bernicla nigricans*, *Anser Rossii*, etc. This, however, may be in consequence of their migrations being along a meridian line, or north and south; the meridian of the westernmost point of California and even of Vancouver's Island passing east of the mouth of the Mackenzie River.

In any investigation into the reasons why the eastern province is of so much greater extent than the others, and exhibits such a trend westward in British America as to reach and even cross the Rocky Mountains, we will be greatly aided by the examination of Prof. Guyot's Wall Map of North America. On this map the country, not exceeding 800 feet in height, is colored green, and this portion is almost exactly coincident with the limits of the eastern province just defined: reaching west of the Mississippi, almost to the edge of the fertile plains (the true zoological boundary), passing up the Mississippi via St. Paul to the Winnipeg valley, involving the whole shores of Hudson's Bay, thence in a northwesterly direction, a little south of Slave Lake to the foot of the Rocky Mountains, and north to the Arctic ocean on both sides of the Mackenzie. Within this vast country are "islands" of more elevated land; the whole Appalachian range, from New Brunswick to Central Georgia and Alabama; the height of land between Hudson's Bay and the St. Lawrence system of waters (nearly parallel with the latter), the plateau of Iowa and Northern Wisconsin, and that east of Slave Lake,[10] etc, being more or less completely encircled by the lower level referred to. The highlands within this region have to a certain extent a peculiar fauna, characterized by the presence of such species to a considerable degree even in summer, as *Junco hyemalis*, *Perisoreus Canadensis*, *Chrysomitris pinus*, *Curvirostra Americana* (more rarely *leucoptera*), *Pinicola Canadensis*, etc., most of which are known to breed in the high mountain region of Georgia. These highlands do not, however, materially alter the summer distribution of our birds, especially in the interior, and there is no physical obstacle, not even that

[10] This region, bounded west by Coppermine river, Slave, Athabasca, and Wollaston lakes, and south by Churchill river, is known as the Barren Grounds of Arctic America, and is a great granitic or azoic region, more or less barren of vegetation, destitute of large trees, and having few inhabitants. It is, however, the especial home of the Musk Ox, the Barren Ground or Small Reindeer, the Barren Ground Bear, the Polar Hare, and other species.

of temperature, to interrupt or affect their passage by way of Rupert's land to the shores of the Arctic ocean."

The southern division of the eastern province is also quite well outlined by Prof. Guyot's limits of the cotton-producing region, although running much farther to the northwest in Arkansas and the Indian Territory than there indicated.

The much greater tendency of the southern birds, or those belonging to the cotton region, to go northward in the Mississippi valley than along the Atlantic slope is explained not only by the ascent there of the isothermal lines, but by the absence of any such obstacle to their journey as is furnished by the Appalachian range.

The great central plateau region of Prof. Guyot's map corresponds quite closely with the middle ornithological province, reaching north to the Saskatchewan and west to the Pacific slope. The close relationship of the western province to the middle is illustrated by the fact that the region of country exceeding 800 feet in height, extends quite to the Pacific in most places, leaving only a few narrow borders and perhaps the valley of the San Joaquin and the Tulare lakes below that level.

It is a fact not without its significance that the depressed lowland area of eastern America is characterized by the existence of certain genera of fishes and reptiles not found in its Appalachian "island." Thus we have *Amia*, *Lepidosteus*, *Micropterus* (*Grystes*), and various other forms of fishes throughout the Mississippi valley as far north as the Great Lakes, while in the Atlantic slope they do not pass the James or Lower Potomac except as stragglers. The soft shelled turtles, and the great mass of the

[11] The Appalachian Region towards the north and northeast passes into a well marked subdivision, called by Prof. Verrill in his paper on the birds of Norway, Maine, the "Canadian." This he correctly characterizes by the presence of certain species during the breeding season, replacing certain near allies, in what, with Prof. Agassiz, we may term the Alleghanian subdivision. Some of the characteristic and more or less parallel species of birds in these two subdivisions he considers to be the following:

Alleghanian.	*Canadian.*
Dendroica discolor,	Dendroica striata,
Pipilo erythrophthalmus,	Chrysomitris pinus,
Spizella socialis.	Curvirostra leucoptera,
	Junco hyemalis,
	Perisoreus Canadensis,
	Picoides arcticus,
	Tetrao Canadensis.

The Canadian sub-province includes especially the highlands between Hudson Bay and the St. Lawrence waters and across them into Northern Wisconsin, the higher portion of the Adirondack, Green, and White Mountains, Northern Maine, and, according to Prof. Verrill, the coast region from Mt. Desert to the southeastern part of New Brunswick, including the islands in the Bay of Fundy. Even far to the south, the high mountain regions of the Alleghanies to Georgia have the same fauna, their most characteristic species of bird being the common blue snowbird, *Junco hyemalis*.

Emydidæ belong to the same low region also, as well as most of the American Perennibranchiate Amphibia, *Menopoma* (more rarely *Menobranchus*) alone penetrating into the Appalachian region, while *Siredon* belongs exclusively to the high central plateau, being found from the Missouri plains to the Cascade mountains of Oregon and south to the city of Mexico.

The *Unionidæ* and *Melaniadæ* seem likewise to belong more especially to the depressed portion of eastern North America.

I may also mention in this same connection that as might be expected, the entire eastern province is characterized by its abundance of Chelonians and Amphibians; the middle and western, by their Saurians. Among fishes the Etheostomoids, Esoces, Siluridæ, the fresh-water Ganoids, (*Amia*, *Lepidostei*, etc.), the fresh-water Percoids, etc., are peculiar to the eastern province, while the great abundance of unusual forms of the *Cyprinidæ* is equally distinctive of the middle and western. As regards the fishes, however, the boundaries of the provinces are considerably changed, the eastern including all the waters emptying into the Missouri river and Gulf of Mexico, the middle embracing the region of the Great Basin and the drainage of the Colorado river, and the western, the waters discharging into the Pacific.

The following tables present the species of birds most characteristic of each province—the selection having been mainly confined to what may be considered as representative species, or those which would formerly have been considered as identical. The isolated species of each province have not been included.

Western.	*Middle.*	*Eastern.*
Buteo montanus.	montanus.	borealis.
elegans.	elegans.	lineatus.
Athene cunicularia.	hypogæa.	
Picus Harrisii.	Harrisii.	villosus.
Gairdneri.	Gairdneri.	pubescens.
Nuttalli.	scalaris.	borealis ?
Sphyropicus nuchalis.	nuchalis.	varius.
Colaptes Mexicanus.	Mexicanus.	auratus.
Trochilus Alexandri.		colubris.
Chætura Vauxii,	Vauxii ?	pelasgia.
Chordeiles popetue.	Henryi.	popetue.
Myiarchus cinerascens.	cinerascens.	crinitus.
Contopus Richardsonii.	Richardsonii.	virens.
Empidonax pusillus.	pusillus.	Traillí ?
difficilis.	difficilis ?	flaviventris.
Turdus nanus.	nanus.	Pallasii.
ustulatus.	ustulatus.	fuscescens.
Sialia Mexicana.	arctica.	sialis.
Geothlypis Macgillivrayi.	Macgillivrayi.	Philadelphia.
Icteria longicauda.	longicauda.	viridis.
Dendroica Audubonii.	Audubonii.	coronata.
Collyrio excubitoroides.	excubitoroides.	ludovicianus.
Vireo Swainsoni.	Swainsoni.	gilvus.
Mimus var. caudatus.	caudatus.	polyglottus.
Harporhynchus redivivus.	crissalis. [tris.	
	Harporhynchus longiros-	rufus.

Thryothorus spilurus.	Thryothorus Berlandieri.	ludovicianus.
Troglodytes Parkmanni.	leucogaster.	Bewickii.
Sitta aculeata.	Parkmanni.	aedon.
Lophophanes inornatus.[11]	aculeata.	carolinensis.
Parus occidentalis.	atricristatus.	bicolor.
Psaltriparus minimus.	septentrionalis.	atricapillus.
Carpodacus Californicus.	plumbeus.	
Zonotrichia Gambelii.	Cassini.	purpureus.
Junco Oregonus.		leucophrys.
Spizella Breweri.[12]	Oregonus.	hyemalis.
Melospiza Heermanni.	pallida.	pusilla.
Peucæa ruficeps.	fallax.	melodia.
Passerella Townsendii.	Cassini.	æstivalis.
Pipilo Oregonus.	schistacea.[13]	iliaca.
" fuscus.	arcticus.	erythrophthalmus.
Agelæus gubernator.	mesoleucus.	
Sturnella neglecta.	phœniceus.	phœniceus.
Scolecophagus cyanocepha-	neglecta.	magna.
Cyanura Stelleri. [lus.	cyanocephalus.	ferrugineus.
Cyanocitta Californica.	macrolophus.	
	Woodhousii.	Floridana.
Callipepla Californica.	Meleagris Mexicana.	gallopavo.
	Gambelii.	
Tetrao Obscurus.	Ortyx texensis.	virginianus.
"	Richardsonii.	
" Sabini.	Franklinii.	canadensis.
Ibis guaruana.	umbelloides.	umbellus.
Bernicla nigricans.	guaruana.	ordii.[14]
leucopareia.		brenta.
Querquedula cyanoptera.	Hutchinsii.	
Pelionetta Trowbridgii.	cyanoptera.	discors.
Larus occidentalis.		perspicillata.
		Smithsonianus.
	Chroicocephalus franklini.	atricilla.
Sterna elegans.		regia.
Uria columba.		grylle.

To sum up in brief the conclusions reached in the preceding remarks, it may be stated that the ornithological provinces of North America consist of two great divisions of nearly equal size in the United States, meeting in the vicinity of the 100th meridian, the western half divisible again into two, more closely related to each other than to the eastern, though each has special characters. These three sections form three great provinces to be known as the western, middle, and eastern; or those of the Pacific slope; of the great basin, the Rocky mountains and the adjacent plains; and of the fertile plains and region generally, east of the Missouri. A northern or sub-arctic fauna mixes with and melts into the three, extending far to the south (even into Mexico) along the Rocky mountains. The middle and eastern provinces have each a southern subdivision, the one bordering on Mexico, the other on the Gulf and the Atlantic, and each of these also exhibits a differentiation, the former having a special

[11] Found also in the middle province.
[12] Extends also to the Rocky Mts.
[13] Found also at Fort Tejon?
[14] Found all the way across to the Pacific.

subdivision again into Cape St. Lucas, and the latter into Florida. Northward the eastern province extends more and more westward reaching the Rocky mountains and even westward of them towards the Yukon.

The southern boundary of the middle province of North America may be arbitrarily established as a straight line, drawn from the mouth of the Rio Grande to that of the Yaqui near Guaymas on the Gulf of California, thus throwing into North America the whole of Florida and Lower California.

[To be continued.]

ART. XIII.—*Experiments on Mechanical Polarity*;[1] by PLINY EARLE CHASE. M.A., S.P.A.S.

[Continued from vol. xl, p. 316.]

C. APPARATUS-POLARITY.

FRICTION and the jarring of the apparatus, modified by the degree of velocity imparted to the ring, produce a polarity of their own which should be carefully estimated, and due allowance made for its influence in all delicate and doubtful experiments. In order to determine the directivity of the normal vibrations, independent of any mere current influence, the needle was shielded by a glass, as in the ordinary surveyor's or mariner's compass.

27. When the axis is in the meridian, the polarity appears to be meridional.

28. With the axis in the equator, the polarity is also meridional.

29. If the northern extremity of the axis is inclined to the west, the needle declines to the east.

30. Giving the axis an easterly inclination, the needle declines to the west. The declination is, therefore, *from* the axis in all cases, and we may infer that the earth's rotation exerts a constant tendency to increase the normal declination of the needle.

31. In all positions of the axis there appears to be a slight disposition in the needle to decline to the east, independent of the motion produced by the mere vibration of the apparatus. If this disposition is owing to terrestial currents, it is probable that the declination would be westward in the southern hemisphere, in accordance with Ferrel's law, that, "*in whatever direction a body moves on the surface of the earth, there is a force arising from the earth's rotation which deflects it to the right in the northern hemisphere, but to the left in the southern.*" (Math. Monthly, i. 307.)

[1] From the Proceedings of the American Philosophical Society, vol. x, pp. 155–161.

32. If a candle-flame, or the smoke of an extinguished taper, be brought near to the revolving ring, it will be repelled from the equator, attracted to the poles, and neither attracted nor repelled at a distance of about 30° from the equator.

33. If a magnetic needle is substituted for the taper, it tends to parallelism with the axis at the equator, and dips toward the center as it approaches the poles, in accordance with its general disposition to range itself in the line of strongest vibration. (Exp. 3, Proc. A. P. S., ix, 359.)

D. Revolving Discs attached to the Ring.

a. *Discs Axial.*

34. Whatever may be the position of the axis, there is a very slight axial polarity.

b. *Discs Perpendicular to Axis.*

35. There is no current-polarity.

c. *Discs with 45° East Declination.*

36. If the axis is in the meridian, the needle declines to the east.

37. If the axis is in the equator, when the top of the ring moves south the needle declines to the east, but when the ring moves north the declination is westerly.

38. If the axis is inclined to the meridian, and the disc passes over the needle in the magnetic equator, the declination is easterly; but if the disc is meridional, I am unable to discover any decided current-polarity.

d. *Discs with 45° West Declination.*

39. Placing the axis in the meridian, the needle declines to the west.

40. When the axis is equatorial, the declination is westerly.

41. When the axis is inclined to the meridian, and the disc is equatorial, the needle declines to the west; but if the disc is meridional, it produces no marked polarity.

42. All of the experiments with revolving discs, as well as many of those with fixed discs, appear to be affected by changes in the earth-currents, especially when the motion of the ring is northerly.

The foregoing results are in precise accordance with the theoretical deductions contained in my papers on the "Numerical Relations of Gravity and Magnetism," on the "Influence of Gravity on Magnetic Declination," and on "Gravity and Magnetic Inclination" (Amer. Phil. Soc., Dec. 16, 1864, April 21 and May 19, 1865, and this Journal [2], xxxix, 312; xl, 83, 166), as well as with Dove's discovery that analogous at-

atmospheric states are more frequently found under the same meridian than under the same parallel, and with Mr. Ferrel's demonstrations of the tendency in fluids gyrating normally to move towards the pole, the parabolic route of the cyclones, the lateral pressure of moving bodies, and the disposition of the axis of rotating bodies to parallelism with the earth's axis.[2] (Math. Monthly, i, 307; ii, 95, 380, 382.) The rationale is generally so obvious that the necessity of the experiments may reasonably enough be doubted by some, while others may question the validity of any inferences as to magnetic motions that are drawn from the effect of impulses which are confessedly purely mechanical.

Such doubts may perhaps be removed by considering, 1st, the well-known danger of being led astray by the simplest undetected fallacy in *à priori* reasoning, which renders it desirable to obtain experimental verifications of every philosophical inference; 2d, that if all forms of force are, as is so generally supposed, mutually convertible, the convertibility can only be discovered through their mechanical momentum; and 3d, that *all the experiments illustrate the magnetic influence of a fluid controlled by the reaction of disturbed gravitation.* I have shown that forces proceeding in lines corresponding to those which represent solar and planetary[3] influence produce magnetic deflections equivalent to the observed solar-diurnal, annual, decennial, and secular variations; and if it can be also shown that gravitation is an adequate force, we need seek no farther for a *vera causa*, or for conclusive evidence of the correlation of *all* the great cosmical forces.

Whatever theory we may favor respecting the nature of force, and the manner or medium of its transmission,—whether we consider, with Fresnel and Grove, that the luminiferous and kinetic æther is material and ponderable; with Mossotti and Faraday, that it is imponderable; or with Dana, that the hypothesis of any medium is entirely superogatory[4] (this Journal [2], iv, 379, 382), it will be generally admitted that the quantity of motion is the proper measure of force. In an ordinary tempest, every flash of lightning is followed by a thunder-clap, which is occasioned by the reacting gravitation of the air in the restoration of disturbed equilibrium; and, on the

[2] Mr. Ferrel refers, for a beautiful illustration of some of his propositions, to Foucault's experiments with the gyroscope. (This Journal, [2], xv, 263; xix, 141).

[3] The connection which has been pointed out by Sabine between Schwabe's theoretic course of the solar-spot phenomenon and the magnetic 10–11 year period (Phil. Trans., 1852, Art. VIII) acquires a new interest from Prof. Wolf's continued investigations into the influence of the several planets upon the sun-spot curve. (See Monthly Notices of the Royal Ast. Soc., May 12, 1865.)

[4] Is the "*pulsating molecular force*" of Prof. Dana's hypothesis material or immaterial? If the latter, is it intelligent or unintelligent? How can momentum be imparted by velocity without material mass, unless it be by the direct and voluntary act of a competent intelligence?

other hand, in water-spouts and tornadoes, the flashes seem to follow, instead of preceding, the equalizing action of aërial gravitation. We have never yet been able to measure the electrical and gravitating momenta in such instances of violent commotion; but we can hardly doubt their exact equivalence, in view of the well-established law, that "action and reaction are always equal and in opposite directions." And in consideration of such probable equivalence, it does not seem unreasonable to quote them as standing evidences of that long-desiderated link in the chain of kinetic unity, for the recognition of which the way has been partially prepared by Henry's discovery of the tendency to equality of electric momenta, and the correlation of intensity and quantity-currents (this Journal, [1], xxxviii, 218), Challis's hydrodynamic researches (Phil. Mag., vol. i, sqq.), especially in their application to the explanation of gravity as a necessary resultant of universal æthereal vibrations (Ibid. [4], xviii, 321, 443), Helmholtz's paper, "in which he has pointed out that the lines of fluid motion are arranged according to the same laws as the lines of magnetic force, the path of an electric current corresponding to a line of axes of those particles of the fluid which are in a state of rotation" (Crelle's Journal for 1859, referred to by Prof. Maxwell in Phil. Mag. [4], xxi, 348), Rankine's "Summary of the Properties of Certain Stream lines" (Phil. Mag., Oct. 1864, pp. 282–8), Norton's recent articles on "Molecular Physics" (this Journal, [2], vol. xxxviii, sqq.), and a variety of other physical discussions, some of which I have already cited.

The analogies which were pointed out by Gen. Sabine between the thermal and magnetic curves (Hobarton Obs., I, xli; Toronto Obs., I, xxxviii; St. Helena Obs., I, 38, &c. &c.) have been very fully, and, generally speaking, satisfactorily discussed by Profs. Norton (this Journal, [2], vols. 4, 8, 10, 19, 20) and Secchi, (Phil. Mag. [4], vols. 8, 9), the former directing his attention exclusively to the correspondence between the magnetic and thermal variations, the latter to a hypothetical specific magnetism resident in the sun. *All of the reasoning of both these distinguished physicists can be applied, even more convincingly, in support of the hypothesis that simple gravitation-disturbances correspond to those of magnetism, and many of the difficulties in the way of other theories disappear before such an application.*

Having established the coincidence and equivalence (with opposite signs) of the magnetic and gravitating lines of force (Trans. A. P. S., vol. xiii, Art. VI), the modifying magnetic influence of rotation (Ibid., pp. 120, 129), barometric tides (Ibid., pp. 123–7), winds (Ibid., p. 121, and Proc. A. P. S., x, 104), thermal changes (Gen. Sabine, loc. cit.), and lunar attraction (Proc. A. P. S., ix, 434–8; Trans. A. P. S., xiii, 129; and Gen.

Sabine's Diagrams, Toronto Obs., vol. iii, plate 2), and the probable, if not certain, dependence of the variations of long period upon trade-winds (supra, Exp. 19–24) and planetary positions (Sabine and Wolf, loc. cit.), the hypothesis of any peculiar magnetic æther, electric currents, or specific solar and lunar magnetism, to explain the normal perturbations of the needle, appears to be entirely superfluous and unphilosophical. Every particle of the earth's atmosphere is continually receiving and imparting the heat which is radiated from the earth and sun, its specific gravity constantly changing in such manner as to produce incessant rapid and short oscillations, both in the planes of the earth's thermal meridians[5] and in the great circles which pass through the centers of the earth and sun. The consequent disturbance of equilibrium, which is still further increased by the condensation of vapor, the sun's direct attraction, and the earth's rotation, is counterbalanced by terrestrial attraction, acting most forcibly where the sun is in the horizon, and with the least relative efficiency when the sun is in the zenith (or at noon in the summer solstice, provided the station is extra-tropical).

The pressure thus exerted varies from 0 ℔. to 15 ℔. per square inch. Taking the mean (7½ ℔. per square inch or 1080 ℔. per square foot) as the average equilibrating tendency, we have a force nearly fifteen times as great as that which produces, and more than twenty-eight times as great as that which is produced by a violent hurricane. (Enc. Britan., 8th edit., xiv, 647.) Only an insignificant portion of this mighty energy is exerted in the production of the various atmospheric currents, the remainder being quietly transmitted from molecule to molecule, and manifesting itself in barometric,[6] magnetic, and other meteorological perturbations. The adequacy of our supposed cause will therefore hardly be doubted; and, since its penetrating, pervading influence can be impeded by no material shield or screen, the demonstration of a correlation of heat and magnetism with the force which keeps the planets in their orbits appears to be complete and conclusive.

It is possible that a careful study of the relation of the winds to the various magnetic variations would bring to light other evidences of parallelism as striking as the one I have already pointed out (Proc. A. P. S., x, 104) between the curves of vertical magnetic force and force of wind. Such a study might require special attention to the pressure and velocity of the wind, the times of maxima and minima, and other particulars, the need of which would be suggested by experience.

[5] The earth's most powerful radiation is vertical, or in radial lines; next in intensity is the radiation towards the thermal poles, or along the thermal meridians; on the isothermal parallels, the radiation is comparatively insignificant.

[6] The morning and evening maxima, and the moon minimum of effective pressure, combined with rotation, are the principal causes of the daily barometric tides.

Whatever cause affects at the same instant the magnetic and aërial currents should first manifest itself through its influence upon the needle, on account of the amount of inertia in the air. Upon examining the second volume of the St. Helena Observations, which contains a record of the direction of the wind at intervals of six hours, so arranged as to facilitate a comparison with the magnetic declination, I find in each year, from 1844 to 1847 inclusive, that at one hour before the observation of the wind (and in each year except 1846, at the hour of observation) there was a greater average westerly declination when the wind was nearly east than when it was nearly S. by E. This is shown by the following table, which embraces all the tabulated instances when the wind was E. by N., E., E. by S., or S.S.E., S. by E., or S.

The variation of declination is ascertained, 1st, by subtracting from the observed declination the monthly mean at the same hour; 2d, subtracting the monthly average of the daily means from the mean variation of the day; and 3d, subtracting the latter result from the former. One scale division of the declinometer $=0'{\cdot}711$. Increasing numbers denote decreasing westerly declination.

Year.	E. by N., E., or E. by S.					S.S.E., S. by E., or S.		
	No. of observations.	Var. of decl'n 1 h. before obs. Scale divisions.	Average.	Var. of decl'n at hour of obs. Scale divisions.	Average.	No of observations.	Var. of decl'n 1 h. before obs. Scale divisions.	Average.
1844	11	−5·11	−·46	−10·66	−.97	81	+ 4·77	+·06
1845	10	−3·09	−·31	− ·52	−·05	283	−18·28	−·06
1846	20	−1·16	−·06	+ 4·37	+·22	191	+ 6·78	+·03
1847*	85	−4·96	−·06	−12·95	−·15	12	+ 1·52	+·12
Total,	126	−14·32	−·11	−19·76	−·16	567	− 5·21	−·01

The recent experiments of Marcus, showing the direct conversion of heat into electricity, (see London Chemical News, No. 286; Journal of the Franklin Institute, No. 478,) the well-known atmospheric daily cycles, with two maxima and two minima of electrical intensity,[7] and the tendency of the disturbance-variations of declination, inclination, and total force, to fluctuations which follow the solar-tidal and barometric-tidal hours,[8] are all noteworthy in this connection.

* January to July inclusive.

[7] For some recent interesting observations upon atmospheric electricity, see communications of Dr. A. Wislizenus in the Transaction of the Academy of Sciences, St. Louis.

[8] The long series of observations at Toronto show this correspondence in a very striking manner. See Gen. Sabine's Report, iii, 63, table lvi.

ART. XIV.—*Notice of a new group of Eocene Shells;* by T. A. CONRAD.

IN dividing the Tertiary deposits into groups, according to difference of genera and species, it is objected by some naturalists that the diversity might be occasioned by a difference in depth of water at the same period of time. This and other causes originate a marked variation in the Miocene deposits of Maryland and Virginia, but the palæontologist is never in doubt of the relations of these Miocene localities. When, however, we find two beds in juxtaposition, the testacean groups of which differ entirely in species, and the evidence is clear that they must have lived and died in or near where they are now found, we are justified in giving each group a distinct name, and in supposing that they represent different periods of time. The strata at Vicksburg, Miss., as represented from the base at low water to the top of the Oligocene, decide a point of great importance in Tertiary geology. Neither Lyell, Ruffin, nor Tuomey, who all give a slight notice of Shell Bluff, on Savannah river, say anything of the age and relations of the large Ostrea Georgiana, so abundant there. Fortunately, at Vicksburg this shell occurs in the lower part of the bluff, below the Orbitolite limestone of the Jackson Group, associated with a distinct group of shells peculiar to a well-marked subdivision of Eocene strata. We know nothing from the geologists who have examined Shell Bluff of any species of shell associated with O. Georgiana; but at Vicksburg the species are well preserved, and are remarkable for having no affinity with species above or below them. I propose therefore to distinguish this assemblage of testacea by the name of the Shell Bluff group, the situation of which is in the Upper Eocene. There is no town near its outcrop other than Vicksburg by which its locality could be more precisely indicated, but it is only in Warren Co., Miss., that the group can be clearly defined by other fossils than Ostrea Georgiana.

The following section will show the relative position of this group:

VICKSBURG BLUFF.

Calcareous silt with land shells of recent species,.....	10 to 20 feet.
Bluish and yellowish hardpan, often pebbly,—orange sand,.....	5 " 20 "
Vicksburg Group.—Marl, etc.,.....	60 " 65 "
Jackson Group.—Orbitolite limestone.	
Shell-Bluff Group.—	
Black lignite clay and gray sand with *Ostrea Georgiana* Conrad, *Corbula alta* Con., *Natica? Mississipiensis* Con., *Clavella Vicksburgensis* Con., *Triptonopsis subalveatus* Con., *Busycon nodulatum* Con., ...	5 feet.
Gray or black lignitic clays and sands,.....	25 "
Solid lustrous lignite,.....	3 "

ART. XV.—*Professor Treadwell's Improvements in constructing Cannon;* Address of the President of the American Academy of Arts and Sciences (Prof. ASA GRAY) upon the presentation of the Rumford Medal to Professor TREADWELL, November 15, 1865.

[Extr. from the Proceedings of the American Academy, vol. viii.]

AT the Anniversary Meeting last May, upon the unanimous recommendation of our Rumford Committee, the medal founded by Count Rumford was by the Academy awarded to Prof. Daniel Treadwell, for certain improvements in the management of heat. This medal is now before us. It is the first which the Academy has ever bestowed upon one of its immediate members.

As your organ upon this occasion, before we place this testimonial in the hands of our distinguished associate, it is proper that I should briefly specify the grounds upon which your Committee proposed, and you made, this award. It is well understood, and the terms of the vote distinctly show, that this medal was awarded for an invention or an improvement in the management of heat. It is also well known that this particular improvement is a part,—the initial part, indeed,—of a series of inventions,—applicable to other uses, no doubt,—but through which the character of ordnance has been changed, and its power immensely increased. This was the end and aim of the improvement for which the medal is given.

We may, therefore, and we must upon this occasion, speak of this particular improvement in the management of heat in connection with the mechanical inventions which accompanied and followed it, and to which indeed the former is incidental. For the whole important series of mechanical inventions which I am to recapitulate, the Academy must regret that it has no honors which it can bestow. But their history is upon our records, embodied in the communications addressed to us by their author from time to time; and we can only hope that the country and the world, when at length sensible of their obligations, may render the tardy meed of justice, if not of gratitude.

In his earliest communication,—a pamphlet published in the year 1845,—Mr. Treadwell seems to think that the appropriateness of the term "useful," as applied to an improvement in implements of destruction, may be questioned. We need have no misgivings in this respect. So long as life and property, which the ravages of war destroy, are not the most valuable of human possessions, they may be justly yielded and taken, if need require, for the preservation of those that are. And so nations must always count among their greatest benefactors those whose

inventions increase their strength and defense in war. And certainly those men who, by their inventive genius, revolutionize the art of war, exert a most powerful and enduring influence upon the fate of empires, the course of history, and the progress of civilization.

We in our day, within the last fifteen years, have witnessed a change in the means of attack and defense greater than any made in the two hundred years previous, a change involving a complete revolution in tactics, both on land and on sea. To take a single illustration from heavy ordnance,—in which the importance of the change impresses us when we are told that our strongest forts, armed with the best guns we had ten years ago, could oppose no effectual resistance to the entrance of such ships as are now built into any of our harbors; and that a ship could now be built and armed, which, singly, would overmatch our whole navy as it was in 1855.

Fortunately, the balance is redressed by equal improvement in defense.

The improvement in fire-arms, both great and small, is in their increased range and precision. When the effective range of a musket-bullet was extended from 200 yards to 1400 or more, it became imperatively necessary that ordnance should be improved in the same ratio, or it would be useless, as gunners and horses would be picked off by small arms long before they could effectively reach the enemy. This improvement in guns of great calibre has been made, with consequences the importance of which, present and prospective, cannot be overestimated.

But the point which we have to consider is, that this increased range and precision are entirely dependent on the augmented strength of the gun. The weakness of the gun is the only thing that imposes a limit to the range, short of the absolute strength of the explosive material used. It is the strength of the gun which not only gives the range, but makes rifling possible, with precision and all the advantages of elongated shot. All inventions relating to the different modes of rifling, the form of the projectile, and the devices for breech-loading, are necessarily subordinate to the question of strength: with this sufficient, those become simple problems, to be rapidly determined by the ingenuity of many inventors.

Now the limit of strength of cast-iron and of bronze cannon had long ago been reached. Excepting Captain Rodman's improvement, and certain modern advantages in working and casting metals, no material advantages had been gained over guns cast in the reign of Queen Elizabeth.

But the most effective guns of the present day embody new principles of strength. They are all *built-up* guns. With them are associated the names of Armstrong, Blakely, Whitworth,

Parrott and others. Whatever may be the relative merits of these several varieties, our interest is confined to the question of their strength, that is, to the principles of their construction which have made them stronger than common guns, and rendered their respective subordinate improvements possible.

These principles are two, and their introduction at different times into the manufacture of cannon constitutes two successive steps, and the only steps, which give distinctive character to the guns under consideration. Both originated with Mr. Treadwell.

These two inventions are often confounded, although more than ten years elapsed between them. The confusion is doubtless owing in some degree to the fact that the two are found combined in nearly all the modern built-up guns. The first initiated a system of construction which may be designated as the *coil system;* the second, what may be named the *hoop system.*

The first was successfully applied to the making of cannon by Mr. Treadwell in the year 1842, and a full account of it was published in 1845; the gist of the invention being in so constructing the gun that the fibres of the material shall be directed around the axis of the calibre.

This method of construction is described in Prof. Treadwell's own language as follows: "Between the years 1841 and 1845 I made upwards of twenty cannon of this material [wrought iron]. They were all made up of rings, or short hollow cylinders, welded together endwise; each ring was made of bars wound upon an arbor spirally, like winding a ribbon upon a block, and, being welded, and shaped in dies, were joined endwise when in the furnace at a welding heat, and afterwards pressed together in a mould by a hydrostatic press of 1000 tons' force. Finding in the early stage of the manufacture that the softness of the wrought iron was a serious defect, I formed those made afterwards with a lining of steel, the wrought iron bars being wound upon a previously formed steel ring. Eight of these guns were 6-pounders of the common United States bronze pattern, and eleven were 32-pounders of about 80 inches' length of bore and 1900 pounds' weight."

The soundness and value of this principle of construction were fully confirmed in England by the experiments of Sir William Armstrong in 1855, and attested by his evidence before a committee of the House of Commons in 1863. He there describes his own gun as one "with a steel tube surrounded with coiled cylinders,"—as "peculiar in being mainly composed of tubes, or pipes, or cylinders, formed by coiling spirally long bars of iron into tubes and welding them on the edges, as is done in gun-barrels." His indirect testimony to the originality of Mr. Treadwell's process is equally clear; viz: that, within his knowledge, no cannon had ever been made upon this principle until he

made his own in 1855,—he being, as we must suppose, ignorant of what Mr. Treadwell had done thirteen years before. The statement of Mr. Anderson (witness before the Commons' Select Committee), made before the Institute of Civil Engineers in 1860, is equally explicit as to the nature and value of this method of constructing cannon. And, finally, the high estimate of its importance abroad is shown not only by the honors and emoluments conferred by the British government on the re-inventor, but still more by the actual adoption of this gun as the most efficient arm yet produced. For it must be borne in mind that the faults or failures, complete or partial, of the Armstrong and similar guns, are not of the cannon itself, as originally constructed, but of breech-loading contrivances, of the lead coating of the projectile, or of other subsidiary matters.

That our colleague's original invention, the value of which is now so clearly established, should have been so generally unacknowledged by inventors abroad is his misfortune, not his fault. For, not only were his guns made and tested here, and their strength as clearly demonstrated before 1845 as they have been since, not only was a full account of the process and of the results published here in that year, but a French translation of his pamphlet was published in Paris, in 1848, by a professor in the school of artillery at Vincennes, and Mr. Treadwell's patent, with full specifications, was published in England before Sir William Armstrong began his experiments.

The difficulties to be overcome in making such a gun,—great at all times, as Sir William Armstrong and Mr. Anderson testify, —were far greater in 1842 than in 1863. These difficulties were mainly, if not wholly, in welding large masses of wrought iron in the shape of tubes or cylinders. It is for overcoming these difficulties that this medal is bestowed, and especially for the means and appliances by which this difficult mechanical achievement was effected in the furnace "by the agency of fire."

An incidental but noteworthy part of the improvement was the welding by hydrostatic pressure,—an operation which is just now coming into use in England, but has not yet attracted attention in this country.

We come now to the second improvement in the construction of artillery, the invention of the *hooped gun*.

This is not always clearly distinguished, even by those occupied with the subject, from the gun formed of coiled rings. But a simple statement will bring into view distinctly the new principle of strength here introduced.

If an elastic hollow cylinder be subjected to internal fluid pressure, the successive cylindrical layers of the material composing it, counting from within outwards, will be unequally distended, and the resisting efficiency of the outer layer will be less

than that of any layer nearer the axis. And if the walls of the cylinder are thick, and the internal pressure surpasses the tensile strength of the material, its inner layer will break before the outer one has been notably strained. Hence the tensile strength of a square inch bar of the material is the measure of the maximum pressure the cylinder can bear, when constructed as guns were before the introduction of the improvement now under consideration. The improvement does away with this limit, and enables us to go indefinitely beyond it.

This is accomplished by so constructing the gun that the inner layers are compressed by the outer; whereby the internal pressure is first resisted by the outer layers, which must be distended enough to allow the internal compressed portion to attain its normal condition, before this internal portion, (which is the first to break in the common gun) is subject to any strain at all. It will be perceived that if this principle could be rigorously applied, a cannon could be made so perfect that, when subjected to a bursting pressure, every fibre, from the internal to the external surface, would be at that instant equally extended, each contributing its full share of resistance to fracture. The whole resistance would be proportional to the area of fracture.

This was supposed to be the case in common cylinders before the error was pointed out by Barlow, and also by Lamie and Clapeyron. And it was this erroneous supposition that led Count Rumford to his exaggerated estimate of the force of gunpowder, as tested by its power of bursting gun-barrels. If he had used the theory which gave origin to the hooped gun, his results would nearly have agreed with modern observations.

The demonstration of the superiority of the hooped gun, with detailed directions for its construction, is contained in a paper read before this Academy in February, 1856, and published at the beginning of the sixth volume of our Memoirs. This was the first published account of the invention, which had been patented nearly a year before. Captain Blakely's pamphlet, published in England in 1858, sets forth the advantages of this construction by similar arguments; as also does an elaborate paper read by Mr. Longridge before the Institution of Civil Engineers in February, 1860. Both these gentlemen, however, were engaged in researches upon this subject at an earlier date, but not so early, it would appear, as Mr. Treadwell was.

The validity of the principle, and the soundness of Mr. Treadwell's views upon the whole subject, as set forth in his memoir, have been amply confirmed by special experiments made in England with the Blakely and Whitworth guns, and by experience in this country during the last four years with the Parrott and the Blakely guns.

It must not be supposed that the earlier invention is super-

seded by the later one. That is used in forming the hoops of the Parrott gun, and in most of the British guns. And the best gun which could now be made, as experience has shown, would be composed of a barrel of cast-iron or steel, inclosed and compressed by a cylinder of coil.

We need not discuss the question of priority of invention between Mr. Treadwell and others, competitors for a share in the honor of producing the modern cannon. His independence of each and all of them has never been called in question. Nor will it ever seriously be thought that the previous futile attempts at constructing wrought-iron and banded guns,—foredoomed failures both in theory and practice, and destitute of all pretension to a knowledge of the guiding principles now clearly seen to be essential to success,—should detract in the slightest degree from the great honor which our associate has, by a clear insight into the conditions of the problem and the resources of physical science, so fairly and completely won.

Upon these two inventions has been set the seal of experience. But there is still another memoir, read by Prof. Treadwell before this Academy in April, 1864, and printed soon afterwards, which promises to add a third important improvement in the construction of artillery.

Perceiving that the body of a hooped gun, if made of unmalleable cast-iron, compressed by a soft wrought-iron hoop, must give way, by the fracture of the cast iron, before the hoop can approach the ultimate limit of its strength, and that this was, in fact, a principal cause of the failure of so great a part of the large guns of Blakely and Parrott, Prof. Treadwell, as the principal result of this third investigation, proceeds to show, that, to attain with effect the end sought for by hooping a cast-iron gun, it is necessary to harden the wrought-iron hoop by cold hammering and severe stretching before placing it upon the gun-body. He computes, that, by this simple means, a hooped gun may be made *more than twice as strong* as those which have been constructed by Blakely and Parrott, the materials being in both cases the same.

In this important discovery, as also in other matters discussed in his latest memoir, we are gratified to see, that, although now carrying the weight of more than three score and ten years, our veteran colleague still keeps the lead, which he gained at the start, of his competitors in this race of improvement.

So completely do these three improvements cover the ground, that if the works of all other inventors who claim a share in the great gun of the nineteenth century were lost, the gun could be restored (rifling excepted) from Mr. Treadwell's papers alone.

And now, Mr. Treadwell, in delivering into your hands this beautiful gold medal and its silver duplicate, I have much pleas-

ure in conveying with them the congratulations and best wishes of your associates here assembled; also the expression of their hope that you may yet longer lead the race; and especially that you may long enjoy the scientific honors which you have worthily won; and with them, if it may be so, have the full recognition of the rights, and possession of the advantages, which pertain to your inventions.

SCIENTIFIC INTELLIGENCE.

I. *Correspondence of Prof.* NICKLÈS, *dated Nancy, France, Oct.* 12, 1865.

1. *Jean Thiébaut Silbermann.*—Among the losses which science has experienced of late in France we have to mention that of the Superintendent of the Conservatoire des Arts et Metiers, Mr. Silbermann, the elder, —distinguished as a physicist, and also for his admirable researches in thermal chemistry in which he was associated with Mr. Favre. To a spirit of observation he added extraordinary skill in devising experiments and contriving apparatus and in discovering and remedying defects in the latter. He was obliging to an extreme, and so much interested in the labors of others as to forget what was due to himself. He died without honors or fortune, and left his wife and children almost in a state of poverty.

The following facts are from an autobiographical notice which he prepared some years since at our request. A list of his principal works is added at its close.

J. Th. Silbermann was born Dec. 1st, 1806, at Aspach le Pont, in that part of Alsace which forms the department of the Haut-Rhin. His father, who was a Captain of Artillery, put him early at his scientific studies, and later, let him take the course of the Faculty of Sciences at Strasbourg. Here the young man learned drawing, and acquired a decided taste for physics and chemistry.

Thus prepared, he went to Paris and became apprenticed to Mr. Tecker, a distinguished manufacturer of physical apparatus, where he was able to indulge his taste for experimental physics.

While laboring under this accurate instructor he attended the courses of lectures of the Faculty of Sciences at Paris, and soon attracted the attention of Prof. Pouillet, an associate of Gay-Lussac. Prof. Pouillet made him his experimenter, and also his associate in the investigations he had in process on electricity and heat in which Mr. Pouillet acquired the most of his reputation. Mr. Silbermann thus helped his master to obtain a seat in the Institute.

In 1830, Mr. Silbermann quitted his uncertain position, which gave him unceasing occupation, to accept a place as Engineer of bridges and causeways. He was attached to the works for diking the Rhine, and continued in this capacity until 1836.

But topography and hydraulic works could not make him forget experimental physics. He returned to Paris at the call of Prof. Pouillet, but under better circumstances than before, to be experimenter in physics

in the Faculty of Sciences, and also at the Conservatory of Arts and Trades where Pouillet also gave a course on physics.

Here he remained till 1848, at which time he was appointed Superintendent. It was during this period that his taste for exact workmanship became manifested in lasting results. It was he who engaged Ruhmkorff to make the Melloni apparatus used for repeating Melloni's experiments on the radiation of heat; and Soleil to construct the diffraction and interference apparatus, adapted for exhibiting experiments on these subjects in a course of public lectures. He was the first also to project upon a screen the beautiful phenomena of the polarization of light; they were shown for the first time in 1838, during the course of physics at the Faculty of Sciences.

Exhibitions of this kind on a grand scale were rendered possible by the *heliostat*, which he had constructed, and which is now in common use. It is true that many heliostats were known before, among others those of S. Gravesende, Fahrenheit, Charles, and finally that of Arago, executed by Gambey; but all these instruments were too difficult of use for the lecture room, and even for private study were hardly available. The necessity of these "porte lumières" was keenly felt especially in optics. The heliostat of Silbermann was presented to the Academy of Sciences, on the 27th of February, 1843. It was promptly adopted by physicists, for it met all the mathematical conditions of the problem without loss of precision, and cost but one-third that of Charles, or of Gambey.

It was while he was laboring for the reputation of Pouillet (in 1838) in investigations upon the dilatation of gases, that he had occasion to demonstrate the property of gases of condensing on the surface of thin plates of platinum. It was also about this time that, in a series of experiments on the density of liquids, he employed as *tare* a glass vessel identical in density, form, and capacity with the flask, and in this way arrived at a method always available when it is desired to avoid errors arising from hygrometric or barometric variations.

Silbermann was a man of extraordinary manual dexterity. With the most restricted and the simplest means, he improvised the most delicate apparatus. He justified completely the portrait that Franklin drew of a true philosopher: "He should be able to saw with a file, and to file with a saw." The physicists of Paris knew him well; and when an experiment did not succeed, they resorted to Silbermann, who could generally relieve them of their embarrassment. He was thus the great resource of inventors of all kinds; and not seldom it happened that he left his own labors and sacrificed his time to undeceive the searcher for the philosopher's stone, or for the secret of perpetual motion.

Silbermann was an excellent draftsman. It was he who made the drawings for the plates in Pouillet's Treatise on Physics. He modelled admirably in wax, and without having even learned the art. These artistic gifts show how it happened that his labors sensibly wore upon his system, and finally terminated his career.

By his labors Silbermann was entitled to honors and dignities; but, as with Laurent, his modesty constantly held him back from them. For, at Paris, merit alone is not always enough to ensure elevation; a degree of

audacity, tact, and some patronage are also required. Poor Silbermann had nothing of all this; he did not express himself easily either in words or in writing.

He died July 4th, 1865, well satisfied that, as some return for his services, he should be remembered by those who survive him. Will he be mistaken in this hope? In the giddy steeple-chase which occupies the scientific world of Paris, there is no stopping for those who fall; the prize is for those who reach the goal; it matters little by what means.

List of the Scientific labors of J. Th. Silbermann, taken from Poggendorff's Handwörterbuch.

Instrument for measuring the focal distance of lenses and mirrors, (28 Feb., 1842). This instrument is known as the Focometer.

Heliostat, to direct the beams of the sun into the interior of the camera, as well as into the lecture room, (Feb. 7th, 1842). This instrument is known in science under the name of Silbermann's Heliostat.

Apparatus for demonstrating the phenomena of reflection, refraction and polarization, applicable also to the determination of the angles of crystals, (June 17th, 1844).

Sympiesometer, perfected (1845).

Cathetometer for measuring barometric heights, &c. (July 7th, 1845).

Experiments on the rapidity of motion of Electricity, (March 27th, 1847).

Centesimal alcoholometer.

Apparatus for the comparison of measures.

Apparatus for linear dilatation.

"Comparateur a levier" for measuring meters.

Air-pyrometer for measurement of high temperatures. This apparatus gives the temperature of fusion from 150° to 1,500° C.

Metrical measurements of the human body. Mean of human size. Law of length and breadth. Origin of measures of length, and their relation to the mean stature of the human body.

Finally, those beautiful researches now classic, upon the heat of combination, carried on with Prof. Favre, researches which occupied him more than three years and find their place in all treatises. They are published entire in the "Annales de Chimie et de Physique" for 1853. They are illustrated by some hundreds of experiments.

2. *The works of Lavoisier.*—Chemists who have read the "Chemical philosophy" of Prof. Dumas, know the earnest words with which that chemist, in 1836, entered upon the task of getting out a complete edition of the works of Lavoisier. Our readers are aware from our former communications (this Jour., xxxii, 98, xxxv, 262) that this engagement is on the point of being fulfilled, that the edition is in the press, and that three volumes have already been published at the expense of the State.

Many events have prevented the prompt publication of this important work, although, in 1843, Dumas, then President of the Academy of Science, obtained from the Minister of Public Instruction permission that the publication should be made at the expense of the department. It was not till 1861 that his plan began to be executed; three volumes have appeared; the fourth is in the press; this will be followed by two others, treating of questions on administration, agriculture, political economy, &c.

Lavoisier was a complete man. He was not only remarkable as a chemist and physicist; he was an administrator of no ordinary merit. This is evident in the papers which he has left, and which will appear with the series of unpublished documents that Dumas has collected in part from

the family of Lavoisier, and in part from notes made by this unfortunate savant during his journeys, which, as well as his laboratory notes and other papers, were happily preserved, they having been long in the hands of Arago to whom they were confided by the daughter of Lavoisier.

3. *Magnesium Light.*—The remarkable properties of magnesium light are now familiar to all. (See this Jour., xl, 287.) Some facts have been recently observed that are not yet generally known. As regards its chemical effects, this light is well fitted to render luminous phosphorescent bodies, as was fully ascertained by Mr. Chautard in the month of January, 1865. This is now a lecture-room experiment. Take a series of wide tubes enclosed in a box and filled with phosphorescent substances. All these tubes are white; but when struck by the magnesium light each becomes phosphorescent, taking its own special color. About a year since, also, Mr. Lallemand discovered that a mixture of chlorine and hydrogen will explode under the influence of magnesium light; and, moreover, that this explosion does not take place in darkness, nor under the influence of the red or yellow rays, as had already been remarked for common light by Gay Lussac and Thenard.

Magnesium ignites even in the vapor of water, when it is brought in contact with it in a tube containing magnesium heated over an alcohol lamp; the metal burns with brilliancy, disengaging the hydrogen. Under the same circumstances zinc will not burn except at a much higher temperature. This observation has just been made by Messrs. Deville and Caron; these chemists satisfied themselves that magnesium, when cold, decomposes water in the presence of the feeblest acids, even of carbonic acid.

If this metal were not so expensive its light could be applied to numerous uses. A recent invention of an Italian, Mr. Carlevaris, may perhaps prove to be a successful application of it. In place of the metal, he takes the chlorid of magnesium, which he exposes to a jet of ordinary illuminating gas and atmospheric air with a tenth part of oxygen. The light thus produced is very brilliant and appears to answer admirably for the production of photographic images, or for magnifying them.

At first Mr. Carlevaris used magnesia, and also carbonate of magnesia. But he found afterwards that the chlorid gave better results.

4. *New facts concerning Thallium. Position of Thallium in classification.*—Mr. Crookes persists in arranging thallium near lead (Journ. Chem. Soc., April, 1864), while Mr. Lamy is equally decided in placing it among metals of the 1st section. Each cites facts favorable to his own views. In a review of all these facts and considerations in the Journal of Chemistry and Pharmacy (Nov. 1865) I have shown the possibility of resolving the question by placing thallium with the alkali metals, but also including with it lead and silver. This opinion confirms a theory brought forward twenty years since by Mr. Baudrimont, who even then ranked lead with barium. Now that we have an alum with a base of oxyd of silver, isomorphous with the alum of thallium, that of potassium, etc., there is less objection to putting in the same group all these metals, although in other respects they are quite dissimilar. The facts mentioned tend to show that thallium should be considered as establishing a point of union between the alkali metals on one side, and lead and silver on the other.

5. *Bromo-thallic and Iodo-thallic acids.*—After having established the fact that thallium forms with bromine and iodine the compounds $Tl\,Br^3$, $Tl\,I^3$, I have found also that these compounds act like acids and form with the bromids and alkaline iodids, bromo-thallates and iodo-thallates, perfectly definite and crystallizable (Feb. 1864). These compounds are isomorphous with one another. Further, the acids $Tl\,Cl^3$ and $Tl\,Br^3$ are capable of combining with several equivalents of ether. $Tl\,I^3$ however does not so combine under these circumstances; it has not yet been isolated.—*Comptes Rendus, March*, 1864.

6. *Separation of lead and of bismuth by means of Bromo-thallates.*—There has been till now no process known by which lead can be easily separated from bismuth. The alkaline bromo-thallates, of which I am speaking, furnish us with the means. In fact, when these salts are pure and free from chlorids or from bromids in excess, they do not act upon the salts of lead, while they yield with the salts of bismuth a white precipitate of bromo-thallate of bismuth. This white precipitate is soluble in a concentrated solution of sal-ammoniac. The reagent employed is one of the salts which I have described.

$Br^3\,Tl, Br\,K+4HO$; rhombic tables.

$Br^3\,Tl, Br\,Am+8HO$; crystallized in yellow needles.

$Br^3\,Tl, Br\,Am+4HO$, isomorphous with the first.

Having a limpid solution containing a salt of lead, as well as one of the bromo-thallates of which we have been speaking, it is sufficient to add some nitrate of bismuth to obtain immediately a marked reaction; all the bismuth is found in the precipitate when a sufficient quantity of the bromo-thallate has been employed.—*Journal de Pharm. et de Chim.*, [4], ii, 218.

7. *On detonating Antimony.*—This metal, as Mr. Gore has observed, attaches itself to the negative pole of a pile, when a solution of the chlorid, bromid or iodid is subjected to voltaic action. Various explanations have been given of this peculiarity, and it is not surprising that it has been attributed to catalysis, or to a peculiar condition of the antimony. In preparing this metal, I have found that the deposit of detonating antimony is formed only when operating with a compound containing chlorine, bromine or iodine; and that, moreover, detonating antimony always contains a sensible proportion of a halogen element. I hence conclude that detonating antimony is not a metal in a peculiar condition, but that it owes its explosive property to the presence of a small quantity of a compound similar to chlorid of nitrogen. This explanation, which I first proposed in 1858, is in no way contrary to facts, for chlorid of nitrogen also is produced under the influence of the voltaic pile.

We may then expect to see formed an explosive phosphorus, arsenic, or bismuth, because of the analogies between these elements and nitrogen or antimony.

8. *Existence of chlorids corresponding to peroxyds.*—In treating peroxyd of manganese with hydrochloric acid, free chlorine is obtained, in accordance with the equation $MnO^2+2ClH=2HO+Mn\,Cl+Cl$ (1.)

The treatises add that half the chlorine is set free because the compound corresponding to MnO^2, that is to say the perchlorid $MnCl^2$, does not exist; for if so the equation would be $MnO^2+2ClH=2HO+MnO^2$ (2), with consequently, no free chlorine,

I have ascertained that the perchlorid $MnCl^2$ can really be obtained, and that the same is true of $MnBr^2$ and MnI^2. Various processes lead to this conclusion; the most important requisite is to use as little water as possible. On shaking in a tube, well cooled, peroxyd of manganese with a little ether saturated with chlorhydric gas, a liquid is immediately obtained of a green color which is nothing but a compound of $MnCl^2$ with C^4H^5O. This compound is rapidly reduced and discolored by SO^2, S, Ph, Al, Fe, Zn, PbS, SbS^3, &c.; it takes moistures from the air, and speedily undergoes alteration, giving out the gas ClH. In the presence of much ether it dissolves, changes color and becomes red, like mineral chameleon.

To perform the experiment in a public lecture, a little MnO^2 in powder is put into a white dish, and ether saturated with chlorhydric gas is poured upon it. It is stirred with a glass rod, and immediately the liquid becomes of a beautiful green color.

In default of ether saturated with ClH, chlorhydric acid in a saturated aqueous solution may be used; in this case the liquid becomes at first brown, but it turns green when ether is added. It is a very beautiful experiment.

The bromohydric and iodohydric acids act in the same manner. The products, however, are less stable than those obtained with MnO^2. The sesquioxyd of manganese gives similar results. At the same time I ascertained that the formation of the sesqui-iodid, Fe^2I^3, whose existence has been denied by Gmelin and others, is nevertheless possible when iodohydric gas is made to act upon sesquioxyd of iron and anhydrous ether in a very cold tube. Its stability is not great.

In France the perchlorids (perchlorures) bear the name of singulochlorids (chlorures singuliers) conforming to the denomination of singuloxyds which Dumas has imposed upon peroxyds, such as MnO^2, PbO^2, BaO^2, &c.—*Annales de Chimie et de Physique*, [4], v, 161.

9. *Combinations of Boron with the Halogens.*—Anhydrous boracic acid dissolved in absolute alcohol, and treated with a current of ClH, or BrH, acts like the oxyd just spoken of; that is, its oxygen separates itself from the chlorine and bromine so that it forms chlorid or bromid of boron, which remains in combination with the organic molecule.

Chlorid of boron, $BoCl^3$.—A solution of boracic acid in absolute alcohol absorbs with avidity the anhydrous gas ClH, and becomes oily. It fumes in the air. Water decomposes it, producing boracic acid, chlorhydric acid, and alcohol. It is not volatile. Although the liquid appears to be only a solution, it has a definite composition, expressed by the formula $3BoO^3, 3ClH+5(C^4H^5O)$. Heated, it emits torrents of the gas ClH, containing boron; the thermometer rapidly rises to 85° C. The residue is boracic acid. The volatile part is chloro-boracic ether, $BoO^3+5(C^4H^5O)+9HO$.

With boracic acid, anhydrous ether, and dry ClH, analogous results are obtained, if heat at 100° be employed.

Bromid of boron, $BoBr^3$.—The acid BrH gives very nearly the same results. The ethereal liquid collected at 115° C. has the formula $BoBr^3+13(C^4H^6O^2)+3HO$; or rather $BoBr^3+13(C^4H^5O)+16HO$.

All these ethers are alike in their acrid taste, the white fumes which they emit, and which contain some boracic acid, the accompanying compounds, and finally in their property of coloring dry tumeric brown, a property belonging also to dry chlorhydric gas.

These new compounds act with MnO^2 like ether charged with ClH; that is to say, it transforms it into $MnCl^2$ or $MnBr^2$; the sesquioxyds are equally attacked by it.

10. *Acclimatization of the Ostrich.*—In my letter of April, 1861, I have spoken of the attempts to acclimatize the Ostrich. The Society of Acclimatization continues to watch and encourage these efforts. They now begin to hope that even in temperate climates, the Ostrich may figure among the useful animals. The following are the facts upon which these hopes are founded. We have already seen that these animals can reproduce in captivity, but as yet only in the warm regions of Europe, at Florence, Marseilles, Madrid, or in Algiers. This year, however, a birth of ostriches has taken place in the cooler region of Grenoble, in the garden of acclimatization of the Regional Society of the Alps.

The ostriches at the time of breeding were kept in a chamber. After 46 days two young ones appeared, to which the female seemed as devoted as she had been indifferent to the eggs. On this occasion, as has been before observed, the little ones placed themselves only under the male, and received no nourishment from the parents.

After the results obtained in Spain, and since in England, we may hope also to acclimatize the Cassowary.

11. *Acclimatization of Salmon in Australia.*—After many unsuccessful attempts, arising from the eggs of the Salmon being hatched on the journey, they have at last succeeded in acclimatizing the Salmon in the fresh waters of Australia, and simply by retarding the hatching by keeping them in ice. We have already spoken of these attempts. The Society of Acclimatization at Paris learn from Mr. Ed. Wilson, President of the Society of Acclimatization of Victoria (Australia), that the young fish hatched in 1864 have done wonderfully well, and encourage the belief that their acclimatization and reproduction are assured facts.

12. *Vitality of the Salmonidæ.*—On this occasion, we may recall the results of some experiments that Mr. Millet has undertaken on the circulation in young Salmonidæ, such as the European Salmon, Trout, Greyling (Thymallus), and Coregonus. The result is very important to practical pisciculture.

In the earlier state, the vitality of the Salmonidæ has as its inferior limit $-2°$ C, and as the higher $+30°$ C. With trout, and with the Salmonidæ in general, the necessities of respiration increase with the temperature. Water in which the fish live should be much more aërated, or more frequently renewed, when the temperature is above $+15°$ C. than when it remains below $+10°$ C.

The transportation of embryonic eggs and of young Salmonidæ requires much less air, or less water, at a low temperature, than at a high temperature. The fertilized eggs will bear long journeys, and may be carried great distances, if kept moist at a temperature a little above zero. The most favorable temperature for the development of the young Salmonidæ is between 10° and 15° C.

13. *On the origin of terrestrial magnetism.*—Under this title I have pointed out in this Journal in 1854 (xvii, 116, xviii, 386, xix, 104,) that terrestrial magnetism has no other origin than that of the rotation of the earth; that the sun is a magnet, and also derives its magnetism from its rotation. I recall these facts with reference to a note on this subject published in this Journal, vol. xxxviii, p. 420, Nov. 1864.

14. Bibliography.—*Archives of the Scientific Commission to Mexico*, vol. i. Paris, Imperial Press. 1865.—Besides the regulations organizing the Scientific expedition, decreed Feb. 27th, 1864, this first volume contains a series of memoirs and of instructions, of the highest interest, on the following subjects: On Anthropology, by M. Quatrefages; on Zoology by Milne Edwards; on Botany by Decaisne; on Geology and Mineralogy by Ch. Deville. There are also memoirs and reports by Messrs. Milne Edwards, Boussingault and Vaillant on different interesting Mexican subjects; and others by Baron Gros, &c., relate to the exploration of ancient monuments in Mexico and Xochicalco; on the manufacture of Aztec knives, in obsidian; on the ruins of Yucatan, and finally on different subjects connected with medicine, metallurgy, meteorology, natural history, and the agriculture of Mexico.

15. *Memoirs on the use of iodine and potassium in treating diseases from lead and mercury, and syphilis;* by M. Melsens. Paris, 1865. In 8vo.—The object of this memoir is to show by experiments, the importance of iodine and potassium in the treatment of the diseases above mentioned. This treatment is founded on the power of iodine and potassium to render soluble, and eliminate from the state of double iodids, the metallic compounds which have been introduced into the organism. The facts cited by Mr. Melsens, and the cures performed appear conclusive. He gives also a brief review of experiments in Austria in the mercury mines of Idria, and in the Wieden hospital at Vienna.

16. *Figuier: La Plante.*—Botany illustrated, for popular use. One large vol. in 8vo, with handsome plates and beautiful drawings.—A work well adapted to the parlor from the facility with which the dryest details of natural history are made intelligible to the uninitiated.

17. *Victor Meunier; Science and its followers in* 1864. 2 vols. 12mo. —A critical review of the labors and achievements of men of science, written with much sprightliness and force. Among the principal questions treated are—"Aërial navigation, spontaneous generation, lake dwellings," &c., &c.

18. *Review of Medical Hydrology, both French and foreign, 8th year.*—This review is published every two months at Strasbourg, under the direction of Dr. Aimé Robert, chief editor. It treats of whatever relates to mineral waters, and also is occupied naturally with hydropathy, etc.

19. Obituary.—Dr. Lereboullet. While bringing this letter to a close the sad intelligence reaches us of the death of the geologist Dominique Auguste Lereboullet. He was Dean of the Faculty of Sciences at Strasbourg, and at the same time Professor, with great success, of zoology. He was also Director of the Museum of Natural History in that city. Time fails us to notice his life, which was devoted to constant study, or to speak of his labors, which have given him all kinds of recompense and a high rank among men of science. He died at Strasbourg, Oct. 6th, 1865, at the age of 61. He had been more than 40 years in the Faculty of which he was Dean.

II. CHEMISTRY AND PHYSICS.

1. *On Niobium and its compounds.*—Blomstrand, Marignac and Hermann, have published, respectively, investigations of the compounds of niobium; unfortunately, however, without disposing of the extraordinary difficulties of the subject, and without agreement of results. Blomstrand's conclusions may be briefly stated as follows: There are but two tantalum metals, niobium and tantalum, and these form but two acids, namely, niobic acid, NbO_2, and tantalic acid, TaO_2. Hyponiobic, dianic and ilmenic acids have no existence, and there are no peculiar acids in euxenite. The hyponiobic chlorid of Rose, Nb_2Cl_3, is a peculiar oxychlorid, probably $Nb_4Cl_5O_3$. The hyponiobic acid of Rose is the true niobic acid, and in a purer state is also the dianic acid of v. Kobell; Rose's niobic acid (at first called pelopic acid) is a mixture of niobic acid with tantalic acid, and Hermann was right in asserting that he had found tantalic acid in the columbite of Bodenmais. The equivalent of niobium is about 40. The native tantalates and niobates may be included under the general formula $2RO,5R,O_2$, and there are various mixed or intermediate minerals between the true tantalite of Kimito, $2FeO, 5TaO_2$, and the true niobite of Greenland $2FeO, 5NbO_2$.

Marignac has studied the fluorine compounds of niobium. He arrives at the conclusion that the hypo-fluoniobates contain three atoms of fluorine and that hyponiobic acid has a higher equivalent than that assigned by Rose, namely, 266 in place of 243·2. The crystallographic examination of the hypo-fluoniobates leads to the remarkable result that these salts are isomorphous with the fluo-stannates and fluo-titanates, so that $HnbF_3$ replaces Ti_2F_4 and Sn_2F_4. To explain this isomorphism Marignac assumes that the so-called hypo-fluorid of niobium is an oxy-fluorid and he exhibits the relations between the oxyfluo-niobates, fluo-titanates, and oxyfluo-tungstates, by the following formulas in which it must be observed that atoms and not equivalents are used:

Potassium compounds,	$TiK_2F_6.H_2O$	NbK_2F_5O,H_2O	$WK_4F_4O_2,H_2O$.
Copper compounds,	$TiCuF_6.4H_2O$	$TiCuF_5O,4H_2O$	$WCuF_4O_2,4H_2O$.

According to this view the so-called hypo-niobic chlorid is an oxychlorid $Nb_2O_2Cl_3$, and hypo-niobic acid is Nb_2O_5, and might better be termed oxy-niobic acid. Marignac further shows that the formula $Nb_2O_2Cl_3$ agrees better with Rose's analyses than that given by Rose himself, Nb_2Cl_3. The author promises a further investigation of the subject.

Hermann has published a very extensive and elaborate memoir on the tantalum metals. He admits the existence of three distinct metals, namely: tantalum, niobium and ilmenium. Tantalic and ilmenic acids have respectively the formulas Ta_2O_3 and Il_2O_3; hypo-niobic acid is represented by the formula Nb_2O_3, and niobic acid by NbO_2. The columbite of Middletown contains both ilmenic and hypo-niobic acids; for Hermann's methods of separating the different acids from each other we must refer to the original memoir. According to him the equivalent of ilmenium is 52·37, and that of niobium 52·80, a degree of coinci-

dence which does not increase our confidence in his results.—Blomstrand *in Ann. der Chemie und Pharm.*, cxxxv, p. 198; Marignac in the same, cxxxv, 49; Hermann *in Journal für prakt Chemie*, xcv, p. 65. W. G.

2. *On methyl-benzyl.*—The identity of toluol with methyl-phenyl, $\left.\begin{matrix}C_2\ H_3\\C_{12}H_5\end{matrix}\right\}$, was demonstrated some time since by Fittig and Tollens, but these chemists found that xylol was not identical with ethyl-phenyl $\left.\begin{matrix}C_4\ H_5\\C_{12}H_5\end{matrix}\right\}$, though isomeric with it. Fittig and Glinzer have now shown that xylol is identical with methyl-benzyl, $\left.\begin{matrix}C_{14}H^7\\C_2\ H_3\end{matrix}\right\}$, which may be obtained by the action of sodium upon a mixture of bromid of benzyl $C_{10}H_7Br$, and iodid of methyl, C_2H_3I. As thus prepared xylol boils at 139°. Ethyl-benzyl, $\left.\begin{matrix}C_{14}H_7\\C_4\ H_5\end{matrix}\right\}$, prepared in a similar manner boils at 150° C., and appears not to be identical with cumol.—*Ann. der Chemie und Pharm.*, lvii, p. 47. W. G.

3. *On the detection of chlorine, bromine, and iodine, by means of the spectroscope.*—A. Mitscherlich has succeeded in applying the spectroscope to the detection of extremely minute quantities of chlorine, bromine and iodine, and has thus materially extended the use of the instrument. His process is as follows: The dry solid substance to be examined is to be mixed with half its weight of sulphate of ammonia and one-tenth of its weight of oxyd of copper. The mixture is to be brought into the bulb of a glass tube which is connected at one end with an apparatus for generating hydrogen, while the other end near the bulb is open. Hydrogen is then to be passed through the tube and kindled, after which the bulb with the substance is to be heated slowly. The flame is at first colored by copper, but after the oxyd is reduced the spectrum of the haloid salt of copper makes its appearance as described and figured by the author in a former paper. In this manner without further practice, $\frac{1}{4}$ of 1 per cent of chlorine, $\frac{1}{2}$ per cent of bromine, and 1 per cent of iodine may be detected. As sulphate of ammonia gives a spectrum of its own, its use is disadvantageous when small quantities of chlorine, bromine and iodine occur together. In this case it is better to precipitate with a salt of silver, mix the precipitate with twice its weight of oxyd of copper, and proceed as before. In this manner we may detect $\frac{1}{10}$ per cent of chlorine, $\frac{1}{5}$ per cent of bromine, and $\frac{1}{2}$ per cent of iodine in the precipitate. The spectra follow each other in regular order: first that of chlorid, then that of bromid, and lastly that of iodid of copper; an effect which is due to the different degrees of volatility. When very small traces of bromine and iodine are present with a great excess of a chlorid, a decigramme of nitrate of silver may be added to the solution and the precipitate after standing a short time examined as above. In this manner five milligrammes of bromid of sodium were detected in one pound of chlorid of sodium, the spectrum of bromid of copper lasting five minutes. The process again repeated gave a second spectrum lasting six minutes. Since $\frac{1}{10}$ of a minute is sufficient for the recognition of the spectrum it follows that one ten-millionth of bromine can be detected by the spectroscopic method, and the reaction of iodine is equally delicate. In 6½

pounds of sea water the author detected bromine, the spectrum lasting seven minutes, but the iodine reaction could not be obtained from this quantity of water. When organic substances are to be tested for bromine and iodine a tube with two bulbs must be employed. The oxyd of copper is to be placed in the bulb nearest the flame, and the organic substance in the other; the products of the distillation of the organic matter are thus carried over the heated metallic copper, and in this manner the smallest traces of chlorine, bromine and iodine may be detected even when traces of one are present with a large excess of the others. The author did not succeed in making satisfactory quantitative determinations by the above mentioned process. In conclusion, Mitscherlich states his conviction, based upon spectroscopic investigations, that iodine and nearly all the other metalloids are compound bodies, and promises to describe the experiments upon which this conclusion is founded.—*Pogg. Ann.*, cxxv, p. 629. W. G.

4. *On silicium-methyl.*—Friedel and Crafts have described the preparation and properties of silicium-methyl. By the action of chlorid of silicium upon zinc-methyl the authors obtained a limpid liquid lighter than water boiling at 30°–31° C., and burning with a bright flame which gives off a siliceous smoke. The analyses and vapor density agreed with the formula $Si(\text{C}H_3)_4$.† It is worthy of notice that the boiling point of silicium-methyl is 122° C. below that of silicium-ethyl, which makes a difference of about 30° for each $\text{C}H_2$. By the action of wood-spirit upon silicate of ethyl the authors obtained a liquid boiling between 143° and 147° C., and having the formula $Si\,\text{C}_6H_{16}O_4$, which corresponds to a diethyl-dimethyl silicate. The action of chlorid of silicium upon purified and dehydrated wood-spirit produces normal silicate of methyl and hexa-methylic bisilicate. The former is a colorless liquid with an agreeable ethereal odor, very soluble in water, and burning with evolution of white vapors. Its formula is $Si(\text{C}H_3)_4O_4$. The other silicate is also liquid; it boils at 201°–202·5°. Its formula is $Si_2(\text{C}H_3)_6O_7$. The difference between the boiling-points of the normal silicates of methyl and ethyl is 44° C., or only 11° for a molecule of $\text{C}H_2$. The difference between the boiling-points of the disilicates is 33°, or about 5° for $\text{C}H_2$. —*Bulletin de la Société Chimique*, May, 1865, p. 356. W. G.

5. *On the organo-metallic radicals.*—The researches of von Oefele upon the compounds of sulphur with ethyl have already been mentioned in this Journal. Cahours, without, as it appears, waiting for the completion of von Oefele's investigation, has taken up the subject and has prepared a number of analogous bodies of much interest. By the action of bromine upon sulphid of methyl $(C_2H_3)_2S_2$ the author obtained a body crystallizing in beautiful octahedral amber-colored crystals having the formula $S_2\left\{\begin{matrix}Me_2\\Br_2\end{matrix}\right.$. Oxyd of silver decomposes this substance and yields $S_2\left\{\begin{matrix}Me_2\\O_2\end{matrix}\right.$ which is entirely neutral to test paper. Iodid of methyl acts energetically upon sulphid of methyl and yields a white crystalline mass having the formula $S_2\left\{\begin{matrix}Me_3\\I\end{matrix}\right.$. The crystals become brown under the in-

† Si = 28.

fluence of light, and with oxyd of silver yield $S_2 \left\{ \begin{matrix} Me_3 \\ O \end{matrix} \right.$, which possesses extremely energetic alkaline properties. The salts of tri-methyl sulphurine crystallize well, but are usually deliquescent. The iodid of ethyl-dimethyl sulphurine $S_2 \left\{ \begin{matrix} Me_2 \\ Et \\ I \end{matrix} \right.$, may be prepared in a similar manner, and yields a basic oxyd and crystalline salts. Iodid of methyl unites with tellurid of methyl to form a crystalline mass which has the formula $Te_2 \left\{ \begin{matrix} Me_3 \\ I \end{matrix} \right.$. With oxyd of silver this salt yields a basic oxyd. A similar ethyl compound also exists as well as analogous bodies containing selenium in place of tellurium or sulphur. Sulphid of allyl also combines with iodid of methyl, yielding the iodid of tri-allyl sulphurine $S_2 \left\{ \begin{matrix} (C_6H_5)_3 \\ I \end{matrix} \right.$. Bromid of ethylene, $C_4H_4Br_2$, unites with sulphid of methyl to form a bromid having the formula $C_{12}H_{16}Br_2S_4 = S_4 \left\{ \begin{matrix} (C_2H_3)_4 \\ (C_4H_4)'' \\ Br_2 \end{matrix} \right.$. This bromid yields a basic oxyd and well defined salts. Brominated bromid of ethylene $C_4H_3Br_3$ unites with sulphid of methyl to form a bromid having the formula $S_6 \left\{ \begin{matrix} (C_2H_3)_6 \\ (C_4H_3)''' \\ Br_3 \end{matrix} \right.$. Iodoform C_2HI_3 gives an analogous iodid. It is easy to see that all the above mentioned compounds belong to the types S_2X_4, S_4X_8, or S_6X_{12}, and that sulphur, selenium and tellurium must be regarded in these compounds as tetratomic.—*Bulletin de la Société Chimique*, July, 1865, p. 40. W. G.

6. *On some salts of teroxyd of thallium.*—STRECKER has described several interesting salts of the teroxyd of thallium which possesses well marked basic properties. Raw chlorid of thallium crystallizes from a solution of carbonate of soda in white feathery groups of crystals, while a small portion remains in solution and may be precipitated by iodid of potassium. In alkaline solutions thallium is easily though not completely reduced by organic substances, such as grape, or milk sugar; on boiling the metal separates as a gray porous mass. When hypo-chlorite of soda is added to a solution of proto-chlorid of thallium in carbonate of soda, a brown precipitate of teroxyd of thallium is gradually formed which settles slowly and may be washed by decantation. According to Strecker the teroxyd is anhydrous; warm dilute sulphuric acid readily dissolves it to a salt which, dried in air, has the formula $TlO_3 . 3SO_3 + 7HO$; the salt when dried at 220° C. contains only one equivalent of water. Heat decomposes the sulphate according to the equation

$$TlO_3, 3SO_3 + HO = TlO . SO_3 + SO_3 + HO . SO_3 + 2O.$$

The sulphate combines with the sulphates of soda and potash to form double salts which have respectively the formulas

$$TlO_3, 3SO_3 + NaO, SO_3 \text{ and } TlO_3, 2SO_3 + 2(KO, SO_3).$$

Oxalate of ammonia gives a heavy white precipitate in a solution of the

sulphate of teroxyd of thallium in dilute sulphuric acid. The precipitate may be washed with cold water in which it is quite insoluble. Boiling water decomposes this salt with evolution of carbonic acid. Heated in a glass tube the thallium is reduced and is easily fused to a single globule. The salt has the formula $TlO_3, 3C_2O_3 + NH_4O, C_2O_3 + 6aq$. Strong nitric acid dissolves teroxyd of thallium, forming a crystalline nitrate which has the formula $TlO_3, 3NO_5 + 6aq$. The solution of this salt gives a siskin-green precipitate with ferro-cyanid of potassium and a yellow precipitate with the ferrid-cyanid. Iodid of potassium produces a black precipitate which is doubtless a ter-oxyd. Strecker suggests that thallium presents analogies both with monatomic and triatomic elements and does not lend support to the theory of the invariability of atomicities.—*Ann. der Chemie und Pharm.*, lix, p. 207. W. G.

7. *On the synthesis of butyric and capronic ethers.*—Frankland and Duppa have published a preliminary notice of the very interesting and important results of their investigation of the alternate action of sodium and iodid of methyl or ethyl upon acetic ether. Frankland and Kolbe in 1857 proposed to refer acetic acid and many other organic bodies to the type of carbonic acid, an atom of methyl taking the place of an atom of hydrogen. In this manner the formula of acetic ether, using atomic instead of equivalent weights, becomes $C\left\{\begin{matrix} C\{H,H,H \\ O \\ OC_2H_5 \end{matrix}\right.$. If one atom of hydrogen in the atom of methyl be replaced by an atom of methyl we shall have propionic ether $C\left\{\begin{matrix} C\{CH_3,H,H \\ O \\ OC_2H_5 \end{matrix}\right.$. The replacement of a second atom of hydrogen and methyl should yield butyric ether $C\left\{\begin{matrix} C\{CH_3,CH_3,H \\ O \\ OC_2H_5 \end{matrix}\right.$, which would also be formed by replacing one atom of hydrogen in acetic ether by ethyl. The replacement of two atoms of hydrogen in acetic ether by two of ethyl should yield capronic ether $C\left\{\begin{matrix} C\{C_2H_5,C_2H_5,H \\ O \\ OC_2H_5 \end{matrix}\right.$, and finally the replacement of three atoms of hydrogen by three of amyl should yield margaric ether $C\left\{\begin{matrix} C\{C_5H_{11},C_5H_{11},C_5H_{11} \\ O \\ OC_2H_5 \end{matrix}\right.$. By the action of sodium upon acetic ether a crystalline mass is obtained which

with iodid of ethyl yields, among other products, butyric ether from which the acid may easily be obtained. The reaction by which butyric ether is obtained may be expressed by the equation $C\left\{\begin{matrix} C\left\{\begin{matrix} Na \\ H \\ H \end{matrix}\right. + \overset{C_2H_5}{I} \\ O \\ OC_2H_5 \end{matrix}\right\} =$ $C\left\{\begin{matrix} C\left\{\begin{matrix} C_2H_5 \\ H \\ H \end{matrix}\right. \\ O \\ OC_2H_5 \end{matrix}\right. + NaI$. By the action of iodid of methyl upon disodium-acetic ether the authors obtained an acid also identical or isomeric with butyric acid, the reaction being $C\left\{\begin{matrix} C\left\{\begin{matrix} Na \\ Na \\ H \end{matrix}\right. + 2\overset{CH_3}{I} \\ O \\ OC_2H_5 \end{matrix}\right\} = C\left\{\begin{matrix} C\left\{\begin{matrix} CH_3 \\ CH_3 \\ H \end{matrix}\right. \\ O \\ OC_2H_5 \end{matrix}\right. + 2NaI$. The authors leave it for the present undecided whether acids having the formula of butyric acid, obtained by different processes, are identical or only isomeric. By the action of iodid of ethyl upon disodium-acetic ether the authors obtained an ether isomeric or identical with capronic ether. Chemists will await with impatience the completion of this investigation, promising, as it does, to lead to results of the greatest theoretical interest.—*Ann. der Chemie und Pharm.*, lix, p. 217. W. G.

8. *On the heat of friction;* by Prof. JOSIAH P. COOKE, Jr. (Proc. of the Amer. Acad. of Arts and Sci., vi, April, 1865).—An accident to one of the large turbine wheels employed by the Merrimack Manufacturing Corporation of Lowell has furnished a most remarkable illustration of the modern mechanical theory of heat, and through the kindness of Mr. Isaac Hinckley, the accomplished agent of the Corporation, I have the pleasure of bringing the facts to the notice of the Academy. I cannot do better than to begin by reading Mr. Hinckley's own statement, in a letter addressed to me, dated December 30th, 1864. The specimens referred to in the letter I have placed on the table for the inspection of the Academy.

"In accordance with your request, I herewith send you five pieces of metal, once portions of one of our turbines. I have placed these pieces in the box in the same relative position which they occupied when they made a part of the turbine. To make my statement clear to you, I would refer to Plate I, of Mr. Francis's admirable work, 'Lowell Hydraulic Experiments,' which you will find in the College Library. Our turbines are similar to the Tremont turbines therein shown.

"The turbine of which these pieces were a part is one of 250 H. P., under a fall of 32 feet, using 75 cub. ft. of water per second. The wheel is of 58½ inches diameter, with depth of float of 6 inches, and a velocity of 144 revolutions per minute. Its position is horizontal, and at a level of 3 feet below the surface of Merrimack River at its ordinary stage. It is mounted upon a vertical wrought iron shaft 25 feet long

and 6 inches diameter at smallest place. This shaft is fitted at its upper end with a series of disks, by means of which it is supported in its box, which is again supported by a massive cast-iron frame. This frame supports the entire weight of the wheel and shaft. The shaft at its lower end is bored in the line of its axis to a depth of 5½ inches to receive a steel pin of 17½ inches in length and 2½ inches in diameter, and which projects from the shaft 12 inches. The steady-pin has no function to perform other than that of restraining the shaft from lateral aberration. It is free to revolve in a box made of three pieces of case-hardened iron, so placed in a cast-iron frame as to allow free play to the steady-pin and the free access of water to it. Each of these three pieces composing this box is kept up to its place by following-screws working in the cast-iron frame which is bolted to the stone floor of the turbine pit. In the Tremont turbine this floor is of wood, and in Plate I, the steady-pin is marked 'I.'

"The pieces sent are marked Nos. 1 to 5. No. 1 is the portion of the steady-pin which was nearest the shaft; No. 2, the other extremity of the same pin; Nos. 3, 4, 5, the three pieces of case-hardened iron forming the box, with portions of the steady-pin attached. You will at once perceive that this steel has been partially fused, and can thus account for its attachment to the iron.

"The facts are, that on noticing some irregularities of motion on the part of the wheel, it was stopped, and the water pumped from the pit until the floor was bare. Inspection showed that the following-screws had not done their duty uniformly; and the three pieces, Nos. 3, 4, 5, no longer preserved their proper relative positions, nor allowed free play to the steady-pin. The consequence was, an amount of friction causing heat sufficient to fuse steel, although the latter was immersed three feet deep in a raceway ten feet wide, through which was passing seventy-five cubic feet of water per second.

"A similar accident happened thrice to our turbines, which are now, however, safely guarded against such mishaps."

There are two points in connection with these facts to which I wish especially to call attention. In the first place, the weight of the wheel did not rest upon the surfaces of friction. The three pieces of case-hardened iron in their displaced position acted simply as a brake upon the revolving shaft, so that the heat must have resulted wholly from the destruction of mechanical motion. The immense moving power of the wheel, instead of being directed wholly into its appropriate channel, was in part transformed into that mode of atomic motion called heat. In the second place, the temperature attained was at least the welding-point of iron, and this, too, although the heated metal was immersed in a stream of flowing water. It is undoubtedly true, that the spheroidal condition of the water would greatly retard the loss of heat, but still the loss must have been exceedingly rapid. Now the loss, even at the highest temperature attained, must have been fully supplied by the heat generated during the same time; and this must, therefore, have been evolved with equal rapidity at the surfaces of friction. No change in the molecular condition of the iron, and no abrasion of the metal, is at all sufficient to account for this continuous, prolonged, and immensely

rapid evolution of heat, and the facts force upon us the conclusion, that the destruction of mechanical motion is the one and only efficient cause. Moreover, if we admit the generally received principle of mechanics, that motion cannot be annihilated, the conclusion that heat is a mode of motion is equally irresistible. Lastly, it is evident that the facts here stated perfectly accord with the well-known experiments of Rumford and Davy; only since the moving power of the Merrimack turbine is so much greater than that employed by these distinguished experimentalists, the results which I have had the pleasure of exhibiting are more striking and conclusive than any which have been previously obtained.

9. *On the Magnetic effects of the Aurora.* (In a letter to the editors from Mr. Moses G. Farmer, dated Salem, Mass., Oct. 2, 1865.)—In the Boston Evening Transcript of Aug. 4th, 1865, was published an account of some observations made by Mr. Geo. F. Milliken, manager of the Boston office of the American Telegraph Company lines, upon the magnetic effects of the aurora.

Mr. Milliken says that in one case, the deflection of the needle of his galvanometer reached 78°, and remained at that deviation for about two minutes. I had the curiosity to insert my Gaugain galvanometer into this same circuit, in order to ascertain the actual value of this deflection. I found it to correspond to the evolution of $\frac{6\,8\,3}{1\,0\,0\,0}$ of a cubic centimeter of mixed oxygen and hydrogen gases per minute, equal to the decomposition of $\frac{3\,3\,9}{1\,0\,0\,0}$ of a grain of water per hour.

Let us assume for the unit of strength of current the evolutions of one cubic centimeter of mixed gases per minute, and let S signify strength of current measured according to this unit. Let the unit of resistance be that offered by one foot of a round wire, one twentieth of an inch in diameter, and made of pure copper, (nearly = 130000 foot-seconds,) and let R denote units of resistance. Denote units of electromotive force by E, then will $E = RS$. Furthermore, denote units of electrical energy by E, then will $E = RS^2 = ES$ express the relations between electrical energy and its corresponding resistance, electromotive force and strength of current. The mechanical value (denoted by M) of this unit of electrical energy is equal to $\frac{1\,9\,1\,4}{1\,0\,0\,0\,0\,0\,0}$ foot-lbs. per minute, or $M = \cdot 0019\ E$.

The measured resistance of the line from Boston to Springfield, including the relays in circuit, was found to be equal to 515970 of our units; hence the electrical energy per minute, exerted by the aurora upon the line while the needle stood at 78°, was $E = 515970 \times (\cdot 683)^2 = 241241$; and its equivalent mechanical value was $M = \cdot 0019 \times 241241 = 46.173$ foot-lbs. per minute.

This wire is of iron, and is one hundred miles in length; it was originally of the wire known as No. 9, hence its volume could not exceed $\frac{\pi}{4} \times (\cdot 148)^2 \times 5280 \times 12 \times 100 = 108925$ cubic inches, $= 63 \cdot 03$ cubic feet. Therefore the mechanical energy per cubic foot of the wire $= \frac{461 \cdot 73}{63 \cdot 03} =$ 7·32 foot-lbs. per minute.

If we suppose the auroral energy to be equally active at all points of space where its presence was evident, we shall find it to amount to

$5280^3 \times 7{\cdot}32 = 1077489008640$ foot-lbs. or more than 32000000, thirty-two millions) of horse-power per cubic mile of space. When we remember that the effects of this aurora, or magnetic storm, were felt in England as noticed by Mr. Airy, and probably upon the Atlantic cable which was then being laid, we can, in some degree, realize what mighty energies may be at play around us, and yet their effects be as harmless as the silvery moonbeams.

II. MINERALOGY AND GEOLOGY.

1. *Pachnolite, a new mineral.*—In searching for crystallized cryolite, Knop has discovered an interesting mineral which occurs in druses and on the lines of cleavage of partially decomposed or weathered cryolite. The mineral is found in two varieties. In one case the crystals rest on the cryolite, and occur in right-angled parallelopipedons with three unequal cleavages parallel to the basal and lateral planes of the crystal. The other variety occurs in druses formed by the solution and removal of the cryolite. These druses are curiously divided by rows of crystals of the new mineral placed end to end, forming little comb-shaped partitions, the center of each partition being in the line of cleavage of the original cryolite. The crystals are lustrous, transparent and colorless, and from their resemblance to hoar-frost, Knop has named the new species *Pachnolite* from *πάχνη*, frost.

Heated gently in the closed tube, the mineral gives off neutral water, at a higher temperature the water has an acid reaction, heated rapidly it is decomposed with crackling and the formation of a white cloud which condenses on the walls of the tube. It is decomposed by sulphuric acid with evolution of fluohydric acid. Chemical composition :

Fe	Al	Na	Ca	$\dot{H}$		
50·79	13·14	12·16	17·25	9·60	=	102·94

from which Knop draws the formula $3(\frac{3}{5}Ca, \frac{2}{5}Na_2)\,Fl + Al_2Fl_3 + 2\dot{H} =$ Fl 51·12, Al 12·29, Na 12·38, Ca 16·14, $\dot{H}$ 8.07=100.

The crystalline form of pachnolite as determined by Knop and v. Rath is trimetric. The crystals occur in simple rhombic prisms sometimes with octahedral planes with pyramidal terminations, and occasionally the pyramidal planes have a stair-like form growing smaller towards the end of the crystal.—*Annalen der Chemie und Pharmacie*, vol. cxxvii, p. 61. [Dr. G. Hagemann, chemist to the Alkali Works at Natrona, Pennsylvania, has in a recent letter communicated to us the results of his investigations of this species, confirming the observations of Knop as to its crystalline form and chemical composition. Dr. Hagemann's analysis gives:

Fl	Al	Na	Ca	$\dot{H}$		
51·15	10·37	12·04	17·44	8·63	=	99·63

It is interesting in this connection to note that cryolite is now imported from Greenland by the cargo to Natrona for the purpose of manufacturing soda ash, alumina salts and other products mentioned in volume xxxv, p. 285.] G. J. B.

2. *On Chrysolite with Chromic Iron in Pennsylvania;* by Dr. F. A. GENTH. From a letter to Prof. Dana, dated Philadelphia, Dec. 10, 1865. —It is about one year ago, since I wrote Prof. Brush of a very interesting discovery which Prof. Booth made, of a large crystal of chrysolite from the great (or once great) chrome mine, called Wood's mine, in Lancaster Co., Pa. The occurrence is the more interesting to me, since, in a certain degree, it confirms my views as to the parent rock of the serpentine and talc of the chrome region. I may add that I have also received chrysolite, associated with hornblende and magnetic iron, from near Media, Delaware Co., Pa., at which locality occur the best crystals of chromic iron.

3. *Crystallized Gold in California.*—Prof. W. P. Blake states that a mass of gold which is for the most part a congeries of imperfect crystals, has been found 7 miles from Georgetown, El Dorado Co., California, which weighs 201 oz., and is valued at $4,000. The mass is now in New York city.

He also has a California crystal of an octahedral form, which if perfect would measure 2 inches on a side.—*In a letter to Prof. Dana.*

4. *On an Asphalt vein in Wood Co., Western Virginia;* by J. P. LESLEY. (Proc. Amer. Phil. Soc., ix, 183, 1863.)—This vein, situated about 20 miles (in an air line) south of Parkersburg, cuts vertically through rocks that are nearly horizontal and have a strike of S. 78° W., while the strike of the county is S. 35°–40° W. It is a vein of a solid bitumen-like substance rather than a coal bed. It resembles the glossiest, fattest caking coals; much of it breaks up into small prisms, and none consists of layers. In an assay made by Mr. B. S. Lyman of Philadelphia, in which the amount of hydrocarbon soluble in benzole was found to be about one-half of the whole, the volatile matter, according to the mean of two assays was 47·11, and of ash 1·73. The substance filling the vein is beyond question, Mr. Lesley observes, a product of the gradual oxydation of coal oil that once filled the open fissure.

5. *Descriptions of Fossils of the Marshall Group of Michigan, and its supposed equivalent in other States;* by Prof. A. WINCHELL.—Prof. Winchell's extensive investigations among the fossils of the sandstones lying between the Devonian Black Shale of the interior basin (equivalent of the Genesee shale of New York), including the beds called the Waverly sandstone in Ohio, and those of the rocks of which his Marshall Group in lower Michigan consists have led him to suggest, if not believe, that these beds are not equivalents, even in part, of the Chemung beds of New York, but rather of certain conglomerates in western New York which have been referred to the inferior Carboniferous. His former identifications of fossils with Chemung species are all abandoned, while an identity with four of the few species of the conglomerate alluded to (found only 4 miles north of Panama, Chautauque Co.) is proved. These four species are *Euomphalus depressus* Hall (Straparollus Ammon *White*), *Cypricardia contracta* Hall (Edmondia? bicarinata *Winchell*), *Edmondia æquimarginalis* Winchell, and *Allorisma Hannibalensis* Shumard. From the facts, he says, "it does not seem unreasonable to suspect a continuity between the more western beds and the supposed Carboniferous conglomerate," at least until observation shall have demonstrated that the Mar-

shall Group is in stratigraphical position really below that formation. The investigations in the more western States tend to confirm this view. The number of species that have been described from the rocks is about 379, 170 of which were first described by Prof. Winchell. The present paper contains descriptions of 94 species, 36 of them new.

6. *On a few of the Fossiliferous localities in Livingston and Genesee Counties, N. Y.;* by HENRY A. GREEN.—(Communicated for this Journal.)—To reach one of the best localities of the Portage group, in this region, proceed about a mile up the ravine of Buck Run, from where it crosses the road a little south of the village of Mt. Morris. The spot may also be reached by going to the house of Mr. Sterling Case, upon whose land it lies, and proceeding along his private road to the ravine. Though much of the Portage group is destitute, or nearly so, of fossils, here is a considerable extent of the shale, at or near the bottom of the ravine, that is comparatively rich in organic remains. Nearly everywhere around this place patient labor will be rewarded with success, but some particular portions are much richer than others. By breaking up only a few cubic feet of the shale, I have procured large numbers of *Ungulina suborbicularis* and *Avicula speciosa.* I have also obtained, though less abundantly, the *Phragmostoma natator*, one or two species of *Retzia, Clymenia complanata, Orthoceras aciculum, Bellerophons, Goniatites*, and several other species of Mollusca.

A little farther up the ravine, I found, at one time, a portion of a fossil plant. The part obtained was nearly a yard long, from two to four inches in width and about half an inch thick. There is but little coaly matter about it, the larger part consisting of pyrites and shale.

At Gibsonville, a few miles west of our village, I have found quite a number of these plants. One of these I traced some six or seven feet. It was about four inches wide, and one-fourth of an inch thick, and was composed of coal.

Along the Cashaqua Creek there are good chances to work, but I have not had as good success as on Buck Run.

Of localities of the Hamilton group, the following are the most productive at present known to me.

The Geneseo localities do not seem to be as well known as some others, though now the most accessible of all, as they lie along or near the railroad. At the quarry near the depot, fragments of the *Phacops bufo* are quite abundant, but perfect specimens are not common. Here I obtained the most perfect *Cacabocrinus liratus* that I have seen. Have also found the same species at York. Of all the specimens I have seen, save this, only the lower half of the head is perfect, while the upper half, showing the arms, has been wanting. A large portion of this specimen is nearly perfect; it shows the forms and markings of the large plates of the lower half, and the smaller hexagonal plates of the upper half, also the bases of the ten arms, which are arranged in five sets.

About a mile south of Geneseo, the railroad crosses Fall Brook at Cuylerville Station. Passing up this creek nearly to the Falls, an abundance of fossils may be obtained; have found specimens of shells here that I have not noticed elsewhere in this region.

Here also is an outcrop of the fish-bearing, pyritiferous beds, though at present covered by a slide of earth, so that only loose slabs can be obtained. Fish remains are not so abundant here as at Moscow, but the bed is crowded with minute *Brachiopoda* and *Gasteropoda*, with some *Pentremites*, *Goniatites* and *Trilobites*.

The richest locality near Moscow is best reached by going north from the church nearly a mile, and turning down the first right hand road. Having crossed the stream just beyond the termination of this road, pass down it a few rods to where the shale is exposed in an abrupt bluff. Both above and below this, along the creek, fossils are very abundant and in fine preservation. Among them are *Atrypa reticularis*, *A. rugosa*, *A. zigzag*, *Phacops bufo*, *Homalonotus DeKayi*, *Nucleocrinus lucina*, and a Crinoid much resembling a *Comatula*. By following up, for a short distance, another branch of this stream, from a point one-eighth of a mile northwest of the village, the characteristic fossils of the Moscow shale may be obtained abundantly.

Intercalated between the beds of the Moscow shale, at this place, are lenticular masses of iron pyrites, from five to thirty feet in diameter, and from one to six inches in thickness. They contain fishbones and teeth in abundance, as well as numerous Brachiopoda, Gasteropoda and Cephalopoda, and occasionally Crinoidea.

Going north from Moscow about three miles, the road crosses Paterson's Creek. A few rods above this point the ravine begins, and along the bottom of this for some distance is a rich spot for the fossil seeker. The *Phacops bufo* and *Cacabocrinus glyptus* are among the choice things that I have found here.

The York locality is best worked near a saw-mill about one-half mile nearly west of the village. By breaking up the hard stratum that forms a slight fall in the stream, close by the mill, a rich harvest may be obtained. This rock holds the *Avicula flabella*, *Microdon bellistriatus* and a variety of rare Conchifers. At nearly all points about the mill, where the rock can be worked, it is productive. Also, at various points along the stream, for nearly two miles below the mill, there are good localities.

A very rich locality lies on the road from Pavilion to East Bethany, and is between one and two miles from the latter place, near the residence of Mr. Frank Peck. Here are found fine specimens of the *Atrypa fimbriata* and *A. hirsuta*, also a *Conocardium* and the *Dalmania callitetes*. To many of the corals found here are attached roots of the Crinoidea, species of *Aulopora*, and quite a number of Bryozoa. On one small bit of coral I have counted five parasitic species. The corals are quite plentiful here, especially *Heliophylli* and *Favosites*.

The Marcellus shale outcrops near Avon and LeRoy. At Littleville, a mile south of Avon, both the limestone and shale of this group are exposed.

A little farther north, along what is called the Little Coneseus, and a few rods above the Erie railroad, is another outcrop.

At LeRoy, just below the Main St. bridge, there is a good chance to work the shale. At each of these points the characteristic fossils of the Marcellus may be obtained.

The Corniferous limestone outcrops in numerous places in this region, but I will indicate only a few of the favorable ones for collecting.

Near Stafford and along the road toward Batavia, this limestone abounds.

The quarries at LeRoy are in the Corniferous. Going east from the village about a mile, on the road to Caledonia, then turning into the first left hand road and following it for about three-fourths of a mile, a point is reached where Corniferous fossils abound. From this locality, proceeding east and southeast, there is a range of rich localities. The corals are mostly silicified, and the rock may be removed by digesting in chlorhydric acid, leaving them in their original perfection.

Note.—Many of the fossils of the Hamilton shales are composed of carbonate of lime. When this is the case the shale may be removed, without injuring the fossil, by letting bits of caustic potash dissolve upon it. The work proceeds quite rapidly where the shale is free from impurities, but an admixture of lime retards, though it does not altogether stop it. Also when very cold the potash acts slowly.

Mt. Morris, Aug. 26, 1865.

7. *Chatham Islands; Peat fifty feet deep.*—In an article on the Chatham Islands, by H. H. Travers, in the Proceedings of the Linnæan Society, ix, 135, the author states the following among many other interesting facts.—The general surface of Chatham Island, except of that part which lies to the south of Petre Bay, is low and slightly undulating, with occasional hills. For example, on the tract to the north of the bay (to the left of the route from Wangaroa to Wari-kauri) there are three or four conical hills, attaining an elevation of 600 or 700 feet, and composed of basaltic and doleritic rocks, and some lower hills near the seacoast on the north side of the island. These hills are clothed with bush from top to bottom. The country to the eastward of the Great Lagoon is very low, scarcely rising in any part more than 50 feet above the sea-level. The peninsula to the south of Petre Bay is more hilly; the hills composed principally of basalts and tufas, and presenting, from Jenny Reef round to Cape Fournier, abrupt escarpments to the sea. The soil is peaty, and is often 50 feet deep. In several parts of the island this peat has been on fire for years, burning at a considerable depth below the surface, which, when sufficiently undermined, caves in, and is consumed. I have seen the loose ashes arising from these fires upwards of 30 feet deep. In one place I noticed, in the burning peat, at the depth of 6 or 7 feet from the surface of the ground, the trunks of trees of a growth evidently far exceeding any that are now to be found on the islands. I was, I am sorry to say, unable to obtain any specimens, in consequence of the great height of the wall of peat and the mass of hot ashes below. The surface-growth (exclusive of bush) consists principally of grasses and sedges, with patches of fern; but I have little doubt that large numbers of indigenous herbaceous plants have been destroyed, partly by the constant firing of the surface by the natives, and partly by the pigs, cattle, and horses which roam all over it. Nearly the whole country had, in fact, been burnt shortly before my arrival.

8. *Notice of some new Types of Organic Remains from the Coal Measures of Illinois;* by F. B. Meek and A. H. Worthen. From the Proceedings of the Acad. Nat. Sci. Philad., March, 1865.—The fossils here described are from Morris, Grundy Co., Illinois, the same with that of the fossil insects described by Mr. Dana in volume xxxvi of this Journal. The species are the Crustaceans, *Belinurus Danæ*, *Acanthotelson Stimp-*

sonii, and *A. inæqualis*, *Palæocaris typus*, *Anthracopalæmon gracilis:* the MYRIAPOD, *Anthracerpes typus;* the INSECT, a Lepidopter, *Palæocampa anthrax*. The specimens are finely preserved. The new genus *Acanthotelson* is Tetradecapodan; that of *Palæocaris* is of uncertain relations, it appearing to combine peculiarities of both the Decapod and Tetradecapod type; but the most important characters for settling the question are not preserved.

9. *Remarks on the Genus* TAXOCRINUS (Phillips) *McCoy*, 1844, *and its relations to* FORBESIOCRINUS Koninck and LeHon, 1854, with descriptions of a new species; by F. B. MEEK and A. M. WORTHEN. From the Proceedings of the Acad. Sci. Philad., Aug. 1865.—The paper shows that the genus Forbesiocrinus is indentical essentially with the older genus Taxocrinus, or only a section of the latter. This paper is followed by another, by the same authors, containing descriptions of new Paleozoic Crinoids of Illinois and some of the adjoining States, and also by a note on the genus *Gilbertsocrinus* of Phillips.

10. *A Catalogue of the Palæozic Fossils of North America*, by B. F. SHUMARD, M.D. 16 pp. 8vo, from the Transactions of the Acad. Sci. of St. Louis, vol. ii, 1865.—This sheet contains the first pages of a catalogue which if completed with thoroughness will be of great service to American Paleontology. The author commences with the North American Echinoderms, gives a long list of works and memoirs on the subject, occupying 6½ pages, and then commences with the list of species and references. Only two genera are included in the part thus far received by us, viz: Acanthrocrinus and Actinocrinus.

11. *Geological Survey of Canada;* PALÆOZOIC FOSSILS, vol. i, 426 pp. 8vo. By E. BILLINGS, F.G.S.—This work consists of descriptions of 446 new species of Lower and Middle Silurian Fossils with re-descriptions and in some instances additional details of about 50 others that were previously published. Sir W. E. Logan, in the preface, says "It has been prepared from time to time, according as the new forms were discovered, or as more perfect specimens of those already known were procured. The only systematic arrangement, therefore, that could be followed, was to group the descriptions together in a series of articles. The first portion, consisting of twenty-four pages, was issued in November, 1861,—the second, pages 25 to 56, in January, 1862,—the third, pages 57 to 168, in June, 1862,—the fourth, pages 169 to 344, in February, 1865, while the remainder, completing the volume, with last date herewith, (Oct. 1865). The first three have been noticed in this Journal under the title of "New Species of Lower Silurian Fossils." There are over 400 good wood engravings. The publishers are Dawson Brothers, Montreal, and Baillière, London, New York and Paris.

12. *Geological Survey of California.* GEOLOGY, volume I. *Report of Progress and Synopsis of the Field-work from* 1860 *to* 1864*;* by J. D. WHITNEY, State Geologist. 498 pp. large 8vo, 1865. Published by authority of the Legislature of California.—The first volume of the Geology of California has just been issued, in the same elegant style with that of the Paleontology before announced. The work is full of interest both to the general reader and the scientific geologist. We propose to notice it at length in another number.

13. *Gold and Silver mines of Montana Territory.*—The amount of gold and silver for 1865 from the mines of Montana Territory, as stated on official authority, will be sixteen millions of dollars. The region was a wilderness in 1862.

IV. BOTANY AND ZOOLOGY.

1. *On the Movements and Habits of Climbing Plants;* by CHARLES DARWIN. (Notice continued from the September number, p. 282.)—*Twiners* and *Leaf-climbers* having been considered, *Tendril-bearers*, which are the highest style of climbing plants, next demand our attention. But our analysis of this important part of Mr. Darwin's treatise must be disproportionably brief.

There are two kinds of movement exhibited by plants, which should be distinguished. 1st. Automatic, usually continued movements, not set in action by extraneous invitation. The gyratory movement of the small leaflets of *Desmodium gyrans* is an exalted instance of this. 2d. Movements in consequence of the contact or action of an extraneous body,—of which those of the leaves of the Sensitive Plant may be taken as the type. Twining stems, as has been seen, strikingly exhibit the first, and their coiling around a support is a consequence of it.

Tendrils for the most part execute both kinds of movement. They revolve, with some exceptions, like twining stems; and they are all more or less sensitive to contact,—usually more so than the petioles of leaf-climbers,—bending towards the impinging body so as to hook or clasp around it, if the size will allow. Different tendrils act differently in some respects, some revolving freely and sweeping wide circuits, some less evidently, and some, like those of Virginia Creeper, do not revolve at all, but turn from the light to the dark. But whether a tendril is the homologue of a leaf, or of a stem (or of a peduncle which is the same thing) appears to make no difference in its action. On the other hand their diversity of gifts in one and the same family, or even in species of the same genus, is very remarkable, as may be seen especially in the Bignonia Family, the Grape Family, &c. So, also, the tendrils are commonly aided in their endeavors by the revolving of the internodes of the stem, but sometimes not, even in plants of the same genus or family. Mr. Darwin takes up tendril-bearing plants by natural families, beginning with Bignoniaceæ, which order contains tendril-bearers, leaf-climbers, twiners, root-climbers, and various combinations of these diverse modes. We, however, will first consider the tendrils of the Gourd, and Passion flower families, regarding them as typical and simple representatives of tendril-climbers.

Passiflora gracilis, a delicate annual species, lately introduced into the gardens, of the easiest cultivation, one which differs from most of its relatives in the young internodes having the power of revolving, is said by Mr. Darwin to exceed all other climbing plants in the rapidity of its movements, and all tendril-bearers in the sensitiveness of its tendrils. In the latter respect it decidedly surpasses our *Echinocystis*; but it is nearly if not quite equalled by *Sicyos*, in which the coiling upon contact was first noticed as a visible movement. The revolving internodes, when in

the best condition, make almost hourly revolutions, and the long, delicate, straight tendrils revolve nearly in the same manner and at the same rate. The sensitiveness of the tendril, when full-grown, is correspondingly great, a single light touch on the concave surface of the tip causing a considerable curvature. "A loop of soft thread weighing $\frac{1}{32}$nd of a grain, placed most gently on the tip, thrice plainly caused it to curve, as twice did a bent bit of thin platinum wire weighing $\frac{1}{50}$th of a grain; but this latter weight, when left suspended, did not suffice to cause permanent curvature." After touch with a twig, the tip begins to bend in from 25 to 39 seconds. After coiling into an open helix upon transient irritation, they soon straighten again, recovering their sensibility; but if left in contact, the action continues. We found it a pretty experiment, last summer, during the warmest days, to bring the upper part of an outstretched tendril by its inner or concave side against a twig or cord, and to see how promptly it would clasp it, revolving its free apex round and round it. A curious discrimination in the sensibility of such tendrils is mentioned by Mr. Darwin, as follows:—

"I repeated the experiment made on the *Echinocystis*, and placed several plants of this *Passiflora* so close together that the tendrils were repeatedly dragged over each other; but no curvature ensued. I likewise repeatedly flirted small drops of water from a brush on many tendrils, and syringed others so violently that the whole tendril was dashed about, but they never became curved. The impact from the drops of water on my hand was felt far more plainly than that from the loops of thread (weighing $\frac{1}{32}$nd of a grain) when allowed to fall upon it, and these loops, which caused the tendrils to become curved, had been placed most gently on them. Hence it is clear, either that the tendrils are habituated to the touch of other tendrils and to that of drops of rain, or that they are sensitive only to prolonged though excessively slight pressure. To show the difference in the kind of sensitiveness in different plants, and likewise to show the force of the syringe used, I may add that the lightest jet from it instantly caused the leaves of a *Mimosa* to close; whereas the loop of thread weighing $\frac{1}{32}$nd of a grain, when rolled into a ball and gently placed in the glands at the bases of the leaflets of the *Mimosa*, caused no action." (p. 90.)

Of Cucurbitaceous tendrils, the most active, after those of *Sicyos* (which Mr. Darwin has not observed), are those of *Echinocystis lobata*. The internodes and tendrils revolve in about an hour and three quarters, the former sweeping a circle or ellipse of two or three inches in diameter, the latter often one of 15 or 16 inches in diameter. Perhaps the most remarkable appearance of discrimination in tendrils is that which Mr. Darwin first noticed in this plant, but which may be seen in others,—and which he thus describes:—

"I repeatedly saw that the revolving tendril, though inclined during the greater part of its course at an angle of about 45° (in one case of only 37°) above the horizon, in one part of its course stiffened and straightened itself from tip to base, and became nearly or quite vertical. . . . The tendril forms a very acute angle with the extremity of the shoot, which projects above the point where the tendril arises; and the stiffening always occurred as the tendril approached and had to pass,

in its revolving course, the point of difficulty,—that is, the projecting extremity of the shoot. Unless the tendril had the power of thus acting, it would strike against the extremity of the shoot, and be arrested by it. As soon as all these branches of the tendrils begun to stiffen themselves in this remarkable manner, as if by a process of turgescence, and to rise from an inclined into a vertical position, the revolving movement becomes more rapid; and as soon as the tendril has succeeded in passing the extremity of the shoot, its revolving motion, coinciding with that from gravity, often causes it to fall into its previous inclined position so quickly, that the end of the tendril could be distinctly seen travelling like the minute hand of a gigantic clock." (p. 75.)

Cucurbitaceous tendrils are mostly compound, in this case three-forked. When one of the lateral branches has firmly clasped any object, the middle branch continues to revolve. If a full-grown tendril fails to reach and lay hold of any object, it soon ceases to revolve, bends downwards, and coils up spirally from the apex. Indeed it often coils while still outstretched and revolving, the tendency to shorten (as we presume) on the inner side from the tip downward, which is usually brought into action by contact with an extraneous body, at length operating spontaneously. Uncaught tendrils when they thus coil up throw themselves of course into a simple helix or spire. One end being free, this is the simple and necessary consequence of the relative shortening of the concave side, sufficiently continued.

In a caught tendril, the relative shortening of one side, (through which the tip hooks round and fixes itself to the supporting object,) being propagated downwards, the whole now throws itself into a spiral form—with more or less promptitude according to the species—thus pulling the free portion of the tendril-bearing shoot nearer to the support, and within easier reach of the next tendril above. Both ends of the tendril being fixed, and the winding round an axis (real or imaginary) necessarily involving or *being* a twist, it is certain that the caught tendril cannot now coil into a simple spiral, but that the spire will be at least double, a coil near one end of the tendril in one direction requiring the other to twist in the opposite direction, unless indeed it undergoes torsion. So, as is familiarly known, there is at least one neutral point in a caught and coiled-up tendril, usually in the middle, the turns on one side of it running from right to left, on the other from left to right. That the coils, whether simple or double and reversed (as the case may be) are not determined by any peculiarity in the tendril, but merely by the relative shortening of one side, may be readily shown by a thread cut from a piece of india-rubber, of unequal tension of the two sides; this, when stretched and allowed to shorten while the two ends are held fast in the same plane, forms at once a pair of reverse coils, or three or four such coils, just as caught tendrils do.

Mr. Darwin explains the point by analogous practical illustrations. He shows, moreover, that an important service rendered by the coiling or spiral contraction "is that the tendrils are thus made highly elastic." In Virginia Creeper, where the ends of the compound tendrils are peculiarly attached, "the strain is thus equally distributed to the several attached branches of a branched tendril; and this must render the whole tendril

far stronger, as branch after branch cannot separately break. It is this elasticity which saves both simple and branched tendrils from being torn away during stormy weather. I have more than once gone on purpose, during a gale, to watch a Bryony growing in an exposed hedge, with its tendrils attached to the surrounding bushes; and as the thick or thin branches were tossed to and fro by the wind, the attached tendrils, had they not been excessively elastic, would have been instantly torn off and the plant thrown prostrate. But as it was, the Bryony safely rode out the gale, like a ship with two anchors down and a long range of cable ahead, to serve as a spring as she surges to the storm."

Moreover, while unattached tendrils soon shrink up or wither and fall off, as we observe in the Grapevine, Virginia Creeper, &c., these same plants show how an attached tendril thickens and hardens, gaining wonderfully in strength and durability. In a Virginia Creeper, "one single lateral branchlet of a [dead] tendril, estimated to be at least ten years old, was still elastic and supported a weight of exactly two pounds. This tendril had five disk-bearing branches, of equal thickness and of apparently equal strength; so that this one tendril, after having been exposed during ten years to the weather, would have resisted a strain of ten pounds."

Our space will not allow even an abstract of Darwin's account of the admirable adaptations and curious behavior of various tendrils, even of some very common plants; as for instance of the familiar *Cobœa scandens*, in which (the stem and the petioles being motionless) the great compound tendril borne at the summit of the leaf executes large circular sweeps with remarkable rapidity, carrying round an elaborate flexible grapnel, consisting of its fine subdivisions, from 50 to 100 in number, which are very sensitive even to a slight touch, bending in a few minutes toward the touched side, so that they clasp twigs very promptly, and all tipped with minute, double or sometimes single, sharp hooks, which catch in little inequalities, and may prevent the tendril-branchlets from being dragged away by the rapid revolving movement before their irritability has time to act, while the still free ones proceed to arrange themselves, by various queer and complicated movements so as to secure the most advantageous hold; then contracting spirally so as to bring other portions up within reach of the support, until all are inextricably knotted and fastened, and finally growing stouter, rigid and strong, binding the plant firmly to its support.

We cannot omit all mention of *Bignonia capreolata*, a not uncommon climber of our Southern States, of which we especially wish to obtain fresh seeds or young plants, that we may ourselves observe the remarkable behavior of its tendrils which Mr. Darwin describes. These are said to turn from the light, as in many other cases; they will clasp smooth sticks, but soon lose their hold and straighten themselves again. A rough, fissured, or porous surface alone satisfies them; their young tips seek and crawl into dark holes and crevices, in the manner of roots; then they develop their hooked extremity, and, especially when they meet with any fibrous matter, the hook swells into irregular balls of cellular tissue, which first adhere to the fibres by a viscid cement, and then grow so as to envelop them. This tendril can do nothing with a smooth post, fails

to attach itself to a brick wall, but is well adapted to climb trees with rough and mossy bark.

The Virginia Creeper also turns its tendrils from the light, and, although they will occasionally clasp a slender support, in the manner of its relative the Grapevine, they uniformly seek dark crevices, or especially broad flat surfaces, as a wall, a rock, or the trunk of a tree. Having brought their curved tips into contact with such a surface, these swell and form, in the course of a few days, the well-known disks or cushions by which they firmly adhere. Here is a tendril-climber, which emulates a root-climber, such as Ivy, in the facility with which it ascends smooth trunks, rocks, or walls.

A very short chapter is devoted to *Hook-climbers* and *Root-climbers*. The stems of the latter are said to "have usually no power of movement, not even from the light to the dark. But *Hoya carmosa*, which twines, also climbs by rootlets spreading over the face of a damp wall; and *Tecoma radicans* (our Trumpet Creeper) exhibits in its young shoots some vestiges of the revolving power with which its twining relatives are endowed."

In a dozen pages of *Concluding Remarks*, Mr. Darwin gives much interesting matter in the way of deduction and speculation, which it would be difficult to condense into an abstract.

Plants become climbers, he remarks, in order to reach the light, and expose a large surface of leaves to its action and that of the free air. Their advantage is, that they do this with wonderfully little expenditure of organized matter in comparison with trees, which have to support a heavy load of branches by a massive trunk. Of the different sorts of climbers, hook-climbers are the least efficient, at least in temperate countries, as they climb only in the midst of an entangled mass of vegetation. Next root-climbers, which are admirably adapted to ascend naked faces of rock; but when they climb trees they must keep much in the shade, and follow the trunk; for their rootlets can adhere only by long-continued and close contact with a steady surface. Thirdly, spiral-twiners, with leaf-climbers and tendril-bearers, which agree in their power of spontaneously revolving and of grasping objects which they reach, are the most numerous in kinds, and most perfect in mechanism; they can easily pass from branch to branch, and securely ramble over a wide and sun-lit surface.

After adducing some considerations in support of his opinion that both leaf-climbers and tendril-bearers "were primordially twiners, that is, are the descendants of plants having this power and habit," Mr. Darwin asks: "Why have nearly all the plants in so many aboriginally twining groups been converted into leaf-climbers or tendril-bearers? Of what advantage could this have been to them? Why did they not remain simple twiners? We can see several reasons. It might be an advantage to a plant to acquire a thicker stem, with short internodes, bearing many or large leaves; and such stems are ill fitted for twining. Any one who will look during windy weather at twining plants will see that they are easily blown from their support; not so with tendril-bearers or leaf-climbers, for they quickly and firmly grasp their support by a much more efficient kind of movement. In those plants which still twine, but

at the same time possess tendrils or sensitive petioles, as some species of *Bignonia*, *Clematis*, and *Tropæolum*, we can readily observe how incomparably more securely they grasp an upright stick than do simple twiners. From possessing the power of movement on contact, a tendril can be made very long and thin; so that little organic matter is expended in their development, and yet a wide circle is swept. Tendril-bearers can, from their first growth, ascend along the outer branches of any neighboring bush, and thus always keep in the full light; twiners, on the contrary, are best fitted to ascend bare stems, and generally have to start in the shade. . . . .

"The object of all climbing plants is to reach the light and free air with as little expenditure of organic matter as possible; now, with spirally-ascending plants the stem is much longer than is absolutely necessary; for instance, I measured the stem of a kidney-bean which had ascended exactly two feet in height, and it was three feet in length. The stem of a pea, ascending by its tendrils would, on the other hand, have been but little longer than the height gained. That this saving of stem is really an advantage to climbing plants I infer from observing that those that still twine, but are aided by clasping petioles or tendrils, generally make more open spires than those made by simple twiners." (p. 110.)

The gradations between one organ and another, and their special endowments, and the great diversity of their movements, are illustrated at length; and the very large number of natural families which exhibit these endowments, in some of their members, is indicated; and it is noted that two or three genera alone have those powers in some of the largest and best defined natural orders, such as *Compositæ*, *Rubiaceæ*, *Liliaceæ*, Ferns, &c.; from which he infers "that the capacity of acquiring the revolving power, on which most climbers depend, is inherent, though undeveloped, in almost every plant in the vegetable kingdom." (p. 117.)

Mr. Darwin somewhere throws out the remark that the larger number and the most perfectly organized climbing plants, as of the scandent animals, belong to one country, tropical America.

In abruptly closing these extracts and brief commentaries, we would add, that the Linnæan Society has issued a separate reprint of this charming treatise, thus opening it to a wider circle of readers. A. G.

2. *Catalogue of Plants found in Oneida County [New York] and vicinity*; by JOHN A. PAINE, Jr. From Report of the Regents of the University of the State of New York, presented March 22, 1865. pp. 140, 8vo. Date at the close, October, 1865.—This full catalogue, upon which much labor has been expended, embraces in fact the whole central part of the State of New York. The actual geographical limits are nowhere indicated, and are perhaps indefinite; but the range appears to extend east to Schenectady, north to the St. Lawrence and Lake Ontario, west to the Genesee River, and south to the tier of counties bordering on Pennsylvania; and in special instances even overpassing these limits. Eighty-one native plants (species and varieties) are enumerated at the close as being additions to the Flora and later catalogue of the plants of the State by Dr. Torrey. But a good many of these, and especially of the twenty-six Carices, are such as depend upon difference of views as to species, some of which have been settled during the many years that

have passed since the publication of the State Flora, and others are still in abeyance. *Dentaria heterophylla*, and *Diplopappus amygdalinus*, for instance, would probably be referred to other species. *Juniperus Sabina*, as the name of the northern prostrate Juniper, although indicated by Hooker, and referred to by Torrey, has waited for Dr. J. W. Robbins (who should be credited with it) to point out "the determining characteristic of the species." The real and specially interesting recent additions to the State Flora are such as these:

Nymphæa tuberosa, Paine, n. sp., the larger-leaved and slightly-scented white Water Lily of the Great Lakes and their tributaries, with the root-stock bearing copious lateral tubers, like "artichokes," and with a defective arillus. It is still to be seen whether the characters will hold out.

Potentilla paradoxa, Nutt., which Mr. Paine found on the shore of Lake Ontario.

Ribes rubrum, which Dr. Vasey is said to have found "on hills north of Salmon Falls,"—wherever that may be. But the general habitat: "swampy woods, low shaded flats of streams, hill-sides, and ravines; frequent," is surely quite wrong!

Solidago Houghtonii, Gray,—before known only from a single, unidentified station in northern Michigan, discovered last summer in an interesting swamp in West Bergen, Genesee County.

Pyrola secunda, var. *pumila:* a curious little form, which we have from Labrador, Lake Superior, and the Rocky Mountains, and which Chamisso indicated long ago on the N.W. Coast. Mr. Paine discovered it abundantly in the high cold bogs south of the Mohawk in which the most northerly sources of the Susquehanna originate.

Polemonium cæruleum,—the habitat in Addenda to Gray's Manual, is confirmed and extended by Mr. B. D. Gilbert.

Najas major, the interesting discovery of which, in Onondaga Lake, has already been recorded in this Journal. It has since been detected in Irondequoit Bay of Lake Ontario, by Mr. E. J. Pickett.

Platanthera rotundifolia: a narrow-leaved variety (*oblongifolia*) of this most rare northern species, was discovered by Mr. Paine along with the *Pyrola* above mentioned.

Cypripedium candidum, a western species, found in the Bergen swamp, with indications of the same farther south and east.

Cypripedium arietinum: found abundantly, with the *Pyrola*, &c.

Tofieldia glutinosa, and especially, *Carex vaginata*, in the West Bergen swamp. (*Carex argyrantha*, Tuckerman, should have been known to belong to the true *C. adusta*, Boott.)

Some of the above, and other plants detected by Mr. Paine in or near Oneida County,—the district of our own earliest botanizing,—fill us with admiration of his activity and sharpsightedness.

Twenty-five plants are enumerated as naturalized species not in the State Flora. But among them are Prickly Poppy, Horseradish, Musk Mallow, Thyme and the like; also *Reseda Luteola* and *Periploca Græca*, which were recorded long ago; *Artemisia biennis*, a very recent waif from the west; and *Rosa setigera*, the Michigan Rose, which we doubt; —the more so as, on turning to its place in the Catalogue (p. 26) we find it mentioned as if indigenous, and with stations which lead us to suppose that some other has been mistaken for this well-marked species.

For a *public document* the Catalogue is well printed, and, as a hasty essay by an unpracticed hand, it is creditable to its author, although there are many points which would not bear close criticism. A. G.

3. *Genera Plantarum*... auct. G. BENTHAM et J. D. HOOKER, Pars II, 1865.—We must now barely announce that the second part of this standard work is just published and has come to hand. It contains the *Leguminosæ*, *Rosaceæ*, *Saxifrageæ*, with the orders close to the latter, the *Haloragеæ*, *Rhizophoreæ*, *Combretaceæ*, and *Myrtaceæ*. The recent illness of Dr. Hooker having delayed his revision of the *Melastomaceæ* for the press, this second part has been cut short of its intended dimensions; but the third part, which may be expected next summer, will complete the Polypetalous Orders and the first volume of a full thousand pages. A. G.

4. *On Morphology and Teleology, especially in the Limbs of Mammalia*, by BURT G. WILDER. (From the Memoirs of the Boston Society of Natural History.)—In this paper the author has brought to view more prominently than has hitherto been done, the remarkable relations existing between the anterior and posterior regions or poles of the Vertebrate body, both as exhibited in the structure of the bones and muscles of the limbs, and the more general relations found in the body itself and the internal organs. This idea usually expressed by "antero-posterior symmetry" was, perhaps, first distinctly enunciated, though in a very general way, by Oken, and has more recently been investigated by Prof. Wyman among others, to whose instruction and suggestions Mr. Wilder attributes many of the ideas so fully elaborated in the present memoir.

Although a large part of the work is devoted to an elaborate and instructive exposition of this peculiar symmetry as exemplified in the bones and muscles of the limbs, which necessarily involves much that is technical and complex in Vertebrate anatomy, there are many interesting and suggestive generalizations discussed in the introductory pages.

It is interesting to observe that the author finds in these investigations no support for the doctrine of serial development of species among animals, or gradual changes in structure through genealogical descent. After demonstrating the doctrine that man is *physically*, as well as mentally, the most highly organized animal,—in perfection of structure and harmonious arrangement of parts far surpassing what we observe in inferior animals, although excelled by some in special functions,—he proceeds to examine the more general relations existing among the four great types of animals, to which the more special principle forming the subject of the essay is subordinate.

In adopting here some views of Prof. Agassiz rather ambiguously and too briefly expressed in a verbal communication,[1] the author evidently labors under a great disadvantage, especially when attempting to present the "*lateрality*" of Mollusca, and "*tergality*" of Articulata, relations which, if they exist, have never been distinctly demonstrated, and which other anatomists and zoologists have failed to discover. Certainly "laterality" has not been shown to characterize Mollusca, in the paper by Mr. Shaler[2] to which he refers, but only bilateral symmetry, which, as

[1] Proceedings Boston Soc. Natural History, viii, 279.
[2] Proc. Bost. Soc. Nat. Hist., viii, 274.

Mr. Wilder justly remarks, is characteristic of *all* animals, even Radiata, as is also *cephality*, as Prof. Dana has fully enunciated in his several articles on cephalization. Mr. Shaler was, moreover, so far misled as to have entirely mistaken the real axial relations among *Brachiopoda* upon which his conclusions were based, as well shown by Mr. E. S. Morse,[3] although the observed *symmetry* still exists, and had been previously shown by others.

In this instance Mr. Shaler considered the valves of Brachiopoda as anterior and posterior, while others, as Owen and Hancock and most anatomists and conchologists, regarded them as dorsal and ventral, the only question being as to which valve was dorsal and which ventral. Either of these three views would obviously allow the same lateral symmetry, a plane dividing the animal in equal halves coinciding with both these axes. But if "laterality" be characteristic, and distinct from lateral symmetry, in Mollusca, it should be more clearly defined than any one has yet been able to do.[4]

The indefinite nature of these terms, as employed by Agassiz, will

[3] Proc. Bost. Soc. Nat. Hist., ix, 57, see also Proceedings Essex Institute, iv, 162.

[4] The remarks of Prof. Agassiz referred to are as follows: "He thought bilateral symmetry should be distinguished from *laterality* which relates to the disposition of the organs on the sides of the body without reference to symmetry; in Mollusks this laterality is on the right and left sides; in Articulates the weight of the organs is on the dorsal and ventral surfaces, for which he would employ the term *tergality;* by *radiality* he would signify the radiated arrangement of the organs in Radiates, and by *cephality* the preponderance of the head and its contained organs in the Vertebrates." If, therefore, laterality expresses the arrangement of organs on the sides without reference to symmetry, it will be apparent that the organs of Articulates,—the legs, jaws, organs of senses, branchiæ, and the wings, spiracles and tracheæ of Insects,—are as definitely arranged upon the sides and with as perfect lateral symmetry as in any Mollusks. Moreover the central nervous ganglions are formed of two lateral parts, and are connected serially by two nervous threads, while the dorsal vessel and alimentary canal are in the median plane. On the contrary, *tergality* is best expressed, if at all, by an antagonism of some organs, which are themselves not homologous, such as the wings of Insects, as contrasted with the legs, various appendages found among Worms, and the dorsal vessel contrasted with the nervous ganglions; but here we find the anterior ganglion *above* the median plane, while the rest are below it, thus showing that such an antagonism of above and below does not exist among these animals, so much as among Mollusca where the heart, when present, is dorsal in respect to the alimentary canal, and the principal ganglion is ventral, while, in some, the valves of the shell themselves are dorsal and ventral. The position of the spiracles and tracheæ in Insects is also such as to refute the idea of "*tergality*" as applied, while they agree with that of laterality. But among Mollusca the "*laterality*" is even less marked than would at first appear if we regarded merely the ordinary bivalve shells. In Gasteropods, Tunicates, and Cephalopods it is certainly less marked than in Articulates, but even in Lamellibranchiates the folds of the mantle, with the valves of shell that they secrete, and the branchial folds, which rest upon the sides of the body, originate dorsally and extend downward upon the sides, while the hinge and its appendages show the importance of their *dorsal* relation to the shell. The organs of respiration do not favor the idea of laterality in many Gasteropods, while in all Mollusca there is as strong contrast or antagonism between above and below as in any Articulates. Thus the foot in the higher orders is neutral, the branchial usually dorsal (*Eolis*, *Doris*, &c., are good examples). The heart and main nervous mass, as before remarked, are as much *opposed* as in Articulates, but do not show any disposition to *laterality*. In fact, had the application of the terms used by Prof. Agassiz been reversed, the true relations would appear to us to have been better expressed.

appear from the following remarks: "We find that in the Mollusks not only are the organs arranged upon the two sides of the body, but the 'weight of organization,' as Prof. Agassiz expresses it, is thrown upon the sides, which even in common usage we recognize to have superior value over the front and hind ends, or the upper and lower edges; we examine and figure only the sides, and, except with the Cephalopoda, their natural position is such as to exhibit prominently one of the sides." Even were these views actually true to nature nothing could be more superficial than such characters. But in fact we place and examine various kinds of shells in very different positions,—the Brachiopoda dorsally or ventrally, the Gasteropods sometimes dorsally, sometimes anteriorly and posteriorly, sometimes laterally, according to their outward forms. The natural positions are, also, equally variable, the bivalve shells themselves more frequently being nearly vertical with the anterior pole downward, but at other times horizontal or oblique with the dorsal region upward, more rarely, as in Ostrea and Pecten, resting upon the sides. In Brachiopods the *ventral* valve appears to be uppermost, according to the homologies of Mr. Morse, while in Tunicates the sides are not more conspicuous than other parts, and the position usually vertical or oblique. Again; "We no more think of placing or viewing an insect on its side than a bivalve upon its upper or lower edge, which correspond to the tergal and ventral regions of the Articulate. This seems to confirm the idea that the single ring representing the Articulate unit is composed of an equal number of segments above and below a horizontal bisecting plane, and that the legs and wings when they exist are tergal and ventral repetitions of each other. But the internal anatomy is less satisfactory, at least as now understood, and I leave it to others more familiar with its details, to determine whether this type, whose sharply defined outlines so clearly illustrate the law, has at the same time the unsatisfactory internal arrangement; it is certain that in our present state of knowledge the laterality of the Mollusks is more apparent than either the tergality of Articulates or the cephality of Vertebrates." The importance of the cephalic character of Vertebrates no one can doubt, but the existence of the same principle in the other types in a marked degree, especially among insects and the higher Mollusca, should prevent the use of this term to express the Vertebrate type. Even the term "tergality" would be more appropriate for Vertebrates than for any other animals, for here we find the body consisting of two distinct arches, the dorsal containing the central nervous system, and the ventral, the organs of nutrition and reproduction, thus presenting a contrast between dorsal and ventral regions seen no where else among animals. The true explanation of these relations seems to be that all these various characters whether laterality, tergality, symmetry or cephality, are most fully exemplified in the Vertebrate structure, while they exist to greater or less extent among lower animals, whether Articulates or Mollusks, and only disappear or are gradually lost sight of in the lower Radiates, owing to the preponderance of the radiate character.

The principle of antero-posterior symmetry or "longitudinality," which the author more specially considers, seems to be characteristic of Vertebrates, and has not been observed among other animals. According

to this law, the anterior and posterior poles of the Vertebrate body have organs and parts that are homologous and morphologically identical, although teleologically very different, while the corresponding parts on opposite *sides* are both morphologically and teleologically repetitions of each other. To follow the various arguments and illustrations of the author would carry us too far, but some of the conclusions are quite remarkable. The body is divided into four regions, the thorax and head, corresponding to the abdomen and pelvis. The center of the body morphologically is supposed to be between the thorax and abdomen, and in embryonic development the cerebro-spinal axis commences in that region, the anterior enlargement or brain being an "after-growth for teleological cause" without any posterior equivalent, but the medulla-oblongata is the part corresponding to the posterior enlargement of the spinal cord, behind the origin of the lumbar nerves. The opposite ends of the alimentary canal, with the adjacent cavities separated from them during embryological development, correspond respectively. Thus, some of the corresponding parts are as follows: "In the anterior region, enumerating from above, that is from the vertebral column downward, the *nose* or *anterior nares*, the *upper lip*, *the mouth*, the *tongue* and the *chin;* posteriorly the *anal opening*, the *perinæum*, the *vaginal opening*, the *penis* or *clitoris*, and the *pubes*." There are two principal diverticula of the alimentary canal, the *lungs* and the *urinary bladder*, the former open forward and the latter backward, and their outlets are between the pharynx or mouth and the tongue anteriorly, and the vaginal opening and the clitoris posteriorly. "The thyroid gland is in relation with the larynx much as the prostrate gland is with the neck of the bladder." The heart is considered only a more or less complicated enlargement and convolution of the great arterial trunk." "Pathology seems to indicate that the testes and the parotid glands are longitudinally homologous; for inflammation of the former is very prone to invade the latter by what is called metastasis." The anterior part corresponding to the uterus is not known. The most remarkable and evident illustrations of this law are however drawn from the limbs, the bones and muscles of which are fully examined from this point of view. The anterior limbs are shown to be appendages of the basal segment of the skull, thrown backward by growth in the higher Vertebrates but occupying their morphological position in Fishes and some young animals. But nothing short of a complete reproduction of his account of the structure of the limbs would do justice to the work, which every one interested in the subject should consult. A. E. V.

5. *Curious Facts in the History of Insects* including Spiders and Scorpions, a complete collection of the legends, superstitious beliefs, ominous signs connected with Insects, together with their uses in Medicine, Art, and as Food; and a summary of their remarkable injuries and appearances; by Frank Cowan, 396 pp. 12mo. 1865, Philadelphia, (J. B. Lippincott & Co.)—This is an interesting book full of the wonders of the Insect world. It is unfortunate that fact and fable are not always easily distinguishable.

6. *The Myriapoda of North America*, by Horatio C. Wood, Jr., M.D., Prof. Botany, Auxiliary Medical Faculty of University of Pennsylvania.

112 pp. 4to, with 3 plates. Philadelphia, 1866. From the Transactions of the American Philosophical Society.—The author has here given a complete treatise, as far as facts have been collected, on the North American Myriapods, describing the genera and species in detail, with full synonymy, and illustrations both by means of wood-cuts and plates. He closes his memoir with a chapter on the natural arrangement of the Myriapoda.

7. *Synopsis of the Polyps and Corals of the North Pacific Exploring Expedition*, under Commodore C. Ringgold and Captain John Rodgers, U. S. N., from 1853 to 1856, collected by Dr. Wm. Stimpson, naturalist to the Expedition; with descriptions of some additional species for the west coast of North America; by A. E. VERRILL. Part II, Alcyonaria, with two plates.—This paper contains descriptions of 2 new species of Pennatulidæ, 4 of Pavonaridæ, 9 of the Gorgonia tribe, and 8 of the Alcyonium tribe, besides notices of other species.

V. ASTRONOMY.

1. *On the Physical History of Meteorites*;[1] by H. C. SORBY, F.R.S.—Though I am most willing to admit that much remains to be learned before we can look upon the following theory as anything more than provisional yet at all events it serves to unite a great number of facts, and is not opposed to any with which I am now acquainted. I shall describe the facts and discuss the objections to this and other theories in a communication to the Royal Society.

As shown in my paper in the "Proceedings of the Royal Society," (xiii, 333) there is good proof of the material of meteorites having been to some extent fused, and in the state of minute detached particles. I had also met with facts which seemed to show that some portions had condensed from a state of vapor; and expected that it would be requisite to adopt a modified nebular hypothesis, but hesitated until I had obtained more satisfactory evidence. The character of the constituent particles of meteorites and their general microscopical structure differ so much from what is seen in terrestrial volcanic rocks, that it appears to me extremely improbable that they were ever portions of the moon, or of a planet, which differed from a large meteorite in having been the seat of a more or less modified volcanic action. A most careful study of their microscopical structure leads me to conclude that their constituents were originally at such a high temperature that they were in a state of vapor, like that in which many now occur in the atmosphere of the sun, as proved by the black lines in the solar spectrum. On cooling, this vapor condensed into a sort of cometary cloud, formed of small crystals and minute drops of melted stony matter, which afterwards became more or less devitrified and crystalline. This cloud was in a state of great commotion, and the particles moving with great velocity were often broken by collision. After collecting together to form larger masses, heat, generated by mutual impact, or that existing in other parts of space through which they moved, gave rise to a variable amount of metamorphism. In some

[1] From a sheet "printed privately" and communicated to the Editors of this Journal.

few cases, when the whole mass was fused, all evidence of a previous history has been obliterated; and on solidification a structure has been produced quite similar to that of terrestrial volcanic rocks. Such metamorphosed or fused masses were sometimes more or less completely broken up by violent collision, and the fragments again collected together and solidified. Whilst these changes were taking place, various metallic compounds of iron were so introduced as to indicate that they still existed in free space in the state of vapor, and condensed amongst the previously formed particles of the meteorites. At all events the relative amount of the metallic constituents appears to have increased with the lapse of time, and they often crystallized under conditions differing entirely from those which occurred when mixed metallic and stony materials were metamorphosed, or solidified from a state of igneous fusion in so small masses that the force of gravitation was too weak to separate the constituents, although they differ so much in specific gravity. (Report of Brit. Assoc., 1864.) Possibly however some meteoric irons have been produced in this manner by the occurrence of such a separation. The hydro-carbons, with which some few meteorites are impregnated, may have condensed from a state of vapor at a relatively late period.

I therefore conclude provisionally that meteorites are records of the existence in planetary space of physical conditions more or less similar to those now confined to the immediate neighborhood of the sun, at a period indefinitely more remote than that of the occurrence of any of the facts revealed to us by the study of geology—at a period which might in fact be called *pre-terrestrial.*

Broomfield, Sheffield, July, 1865.

2. *On the Mineralogical Structure of Meteorites*;[1] by H. C. Sorby, F.R.S.—For some time past I have endeavored to apply to the study of meteorites the principles I have made use of in the investigation of terrestrial rocks, as described in my various papers, and especially in that on the microscopical structure of crystals (Quart. Journ. Geol. Soc., 1858, vol. xiv, p. 453). I therein showed that the presence in crystals of "fluid-, glass-, stone-, or gas-cavities" enables us to determine in a very satisfactory manner under what conditions the crystals were formed. There are also other methods of inquiry still requiring much investigation, and a number of experiments must be made which will occupy much time; yet, not wishing to postpone the publication of certain facts, I purpose now to give a short account of them, to be extended and completed on a subsequent occasion.[2]

In the first place it is important to remark that the olivine of meteorites contains most excellent "glass-cavities," similar to those in the olivine of lavas, thus proving that the material was at one time in a state of igneous fusion. The olivine also contains "gas-cavities," like those so common in volcanic minerals, thus indicating the presence of some gas or vapor (Aussun, Parnallee). To see these cavities distinctly, a carefully prepared thin section and a magnifying power of several hundreds are required. The vitreous substance found in the cavities is also met with

[1] From the Proceedings of the Roy. Soc., June 16, 1864.

[2] The names given thus (Stannern) indicate what meteorites I more particularly refer to in proof of the various facts previously stated.

outside and among the crystals, in such a manner as to show that it is the uncrystalline residue of the material in which they were formed (Mezö-Madaras, Parnallee). It is of a claret or brownish color, and possesses the characteristic structure and optical properties of artificial glasses. Some isolated portions of meteorites have also a structure very similar to that of stony lavas, where the shape and mutual relations of the crystals to each other prove that they were formed *in situ*, on solidification. Possibly some entire meteorites should be considered to possess this peculiarity (Stannern, New Concord), but the evidence is by no means conclusive, and what crystallization has taken place *in situ* may have been a secondary result; whilst in others the constituent particles have all the characters of broken fragments (L'Aigle). This sometimes gives rise to a structure remarkably like that of consolidated volcanic ashes, so much, indeed, that I have specimens which, at first sight, might readily be mistaken for sections of meteorites. It would therefore appear that, after the material of the meteorites was melted, a considerable portion was broken up into small fragments, subsequently collected together, and more or less consolidated by mechanical and chemical actions, among which must be classed a segregation of iron, either in the metallic state in combination with other substances. Apparently this breaking up occurred in some cases when the melted matter had become crystalline, but in others the forms of the particles lead me to conclude that it was broken up into detached globules whilst still melted (Mezö-Madaras, Parnallee). This seems to have been the origin of some of the round grains met with in meteorites; for they occasionally still contain a considerable amount of glass, and the crystals which have been formed in it are arranged in groups, radiating from one or more points on the external surface, in such a manner as to indicate that they were developed after the fragments had acquired their present spheroidal shape (Aussun, &c.). In this they differ most characteristically from the general type of concretionary globules found in terrestrial rocks, in which they radiate from the center; the only case that I know at all analogous being that of certain oolitic grains in the Kelloways rock at Scarborough, which have undergone a secondary crystallization. These facts are all quite independent of the fused black crust.

Some of the minerals in meteorites, usually considered to be the same as those in volcanic rocks, have yet very characteristic differences in structure (Stannern), which I shall describe at greater length on a future occasion. I will then also give a full account of the microscopical structure of meteoric iron as compared with that produced by various artificial processes, showing that under certain conditions the latter may be obtained so as to resemble very closely some varieties of meteoric origin (Newstead, &c.).

There are thus certain peculiarities in physical structure which connect meteorites with volcanic rocks, and at the same time others in which they differ most characteristically,—facts which I think must be borne in mind, not only in forming a conclusion as to the origin of meteorites, but also in attempting to explain volcanic action in general. The discussion of such questions, however, should, I think, be deferred until a more complete account can be given of all the data on which these conclusions are founded.

VI. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *On the geological position of oil wells;* by J. P. Lesley.—In the Proceedings of the American Philosophical Society, at page 189, of vol. x, Mr. Lesley observes that the recent facts he has collected from the valleys of the Sandy, in eastern Kentucky, confirm his view that the oil there comes from the base of the Coal Measures; that "the plants of the great Conglomerate have been converted into thick oil and reach the surface by horizontal drainage over the water-bearing Shales of the False or Lower Coal Measures." The next horizon of oil below this is far down in the Devonian. Mr. Lesley also states the fact that Dr. Newberry has announced that the flow of oil which took place years ago in southern Middle Kentucky came from the Lower Silurian limestones, the same horizon that affords oil in limited quantities near Chicago; and that he himself observed "petroleum trickling from Upper Silurian limestones at Cape Gaspé, Canada East, the surfaces of the limestone bed being almost covered with the vestiges of cocktail fucoids, coralloids, bivalves and trilobites."

2. *Scientific Exploring party in Russian America, connected with the Western Union Telegraph Company.*—[Through the liberality of the Northwest American Telegraph Company, a scientific corps under the direction of Mr. Kennicott accompanies the expedition. We cite the following statements respecting the corps and its operations from a letter received from Mr. W. H. Dall, of the corps, dated At sea, en route for Petropavlovsk, Bark Golden Gate, Oct. 11, 1865.] "Our party, which consists of Mr. Kennicott, Director; J. T. Rothrock, as Botanist; myself, in charge of the Department of marine invertebrates; H. M. Bannister, of the Smithsonian Institution, as Paleontologist; and Henry Elliott and Ferdinand Bischoff as general collectors, are employed by the Telegraph Company as explorers, &c., and the work which we do for natural history is entirely outside of this.

But by the kindness and liberality of Col. Chas. S. Bulkley, in general command, and Capt. C. M. Scammon, Chief of Marine (of the U. S. Rev. M.), both of whom are much interested in science and natural history, we are able to accomplish a great deal in the scientific way.

This year's actual collections are small, as we started late in the season and have paid flying visits everywhere, and our attention has been given mainly to mapping out next season's work, and placing men and outfits where they would be most useful.

The collections are mostly marine, and have been principally made by myself, as the other members of our party have been otherwise employed. They have been made on the surface of the north Pacific and Behring sea, and also by soundings in both; at Sitka, R. Am.; Ounga Island, south of Aliaska; Ounimak Pass, Aleutian Islands, Norton Sound; Behring Strait; Plover Bay, on the Asiatic side; and they will be continued at Petropavlovsk when we arrive there. We shall then leave for San Francisco. Our collections all pass into the hands of Prof. Baird, at the Smithsonian Institution, under certain restrictions.

One interesting result of this year's work was the examination of the lignite, or brown coal beds, at Ounga Island, and the collection of such a series of fossils as will doubtless determine their age.

Our party has been distributed as follows: Mr. Bischoff, with a good outfit, was left at Sitka in Aug. last, and will remain all winter and next spring. Mr. Bannister remains at St. Michaels, Norton Sound, where he will be joined in the early spring by Messrs. Kennicott and Rothrock, now absent in command of exploring parties, and by Mr. Elliott, and probably by Mr. Bischoff, later in the season. By thus concentrating, the natural history operations on the lower Youkon around Norton Sound are likely to prove successful."

3. *On Negro Instruments;* by A. Innes.—In your report of the proceedings of the British Association, in a paper read by Mr. J. Crawfurd, 'On the Physical and Mental Characteristics of the African Negro,' it is stated that "The Negro, also, had never shown ingenuity enough to invent letters, symbolic or phonetic." I beg leave to hand you a drawing of the "Elliembic," or African telegraph, an instrument which has been in existence for time immemorial to the oldest inhabitant in the Cameroons country, on the west coast of Africa. By the sounds produced on striking this instrument, the natives carry on conversation with great rapidity, and at several miles distance. I have one of the instruments now in my possession, which I brought home with me on my last visit to Africa in 1860. The sounds are made to produce a perfect and distinct language, as intelligible to the natives as that uttered by the human voice, and which I had the means of testing on several occasions. The instrument is in universal practice about the Cameroons, and up in the interior, in the Abo and Budi countries, a part of central Africa not yet visited by Europeans. In visiting this part of Africa in 1859, my coming was generally announced beforehand to the different villages by the "Elliembic." I questioned some of the oldest inhabitants as to the inventor; but none of them could tell me further than that they supposed "it must have been some of their great-grandfathers." This "Elliembic," therefore (which is a most ingenious invention), must have been in existence in Africa before telegraphs were dreamt of in England.—*Athenæum, Oct. 14th*, 1865.

4. *Malta cavern.*—The Mnaidva bone-cave, which Dr. Adams discovered in 1863, on the southwest coast of Malta, and which he named after the Phœnician mines close by, is to be further explored, the Geological Section having voted 30*l.* for the purpose. In 1864, Dr. Adams worked at it divers times, until the British Association sent a grant enabling him to clear out fifty-four feet of the cave, which was filled with red earth and stalagmite. Here he found sixty to eighty teeth, and numerous fragments of bones, of at least two species of elephant, one a mere pigmy, the other of larger size, but scarcely equal to the smallest Asiatic elephant; besides vast quantities of a gigantic rat, land tortoise, and swan—the last of colossal dimensions. It has been named *Cygnus Falconerii*, after the distinguished paleontologist, the late Dr. Falconer. Dr. Adams will continue his researches during the winter months.—*Reader, Oct. 28th*, 1865.

5. *Chicago Observatory.*—Mr. T. H. Safford, formerly assistant at the observatory of Harvard college, has been appointed Director of the observatory at Chicago.

6. *London International Horticultural Exhibition.*—Prof. Alphonse de Candolle of Geneva has accepted the Presidency of the Botanical Con-

gress to be held in London in May next, in connection with the great International Horticultural Exhibition, and will deliver an opening address on the mutual relationship of gardening and botany, and the practical results wrought by them. The Congress department has been placed under the care of Dr. Seemann, to whom all communications relating to it should be addressed.—*Reader*, Dec. 9th, 1865.

7. *National Academy of Science.*—The next session of the National Academy of Sciences will open at Washington on the 24th of January.

8. *Origin of lake-depressions.*—This subject receives some important illustrations, accompanied with criticisms upon the glacial theory of Prof. Ramsay, in an article by Prof. J. P. Lesley, in volume ix of the Proceedings of the American Philosophical Society, at page 190.

9. *The Proceedings of the recent meeting of the British Association at Birmingham.*—The best abstracts that have been published of the papers read at the recent meeting of the British Association are contained in the London weekly periodicals, The Reader, numbers 142 to 150 inclusive (Sept. 9 to Nov. 11), and the Athenæum, numbers 1976 to 1981 (Sept. 9, to Oct. 14).

10. *First Annual Catalogue of the Officers and Students, and Programme of the Course of Instruction, of the School of the Massachusetts Institute of Technology*, 1865–6. 40 pp. 8vo. Boston, 1865.—This first Annual Catalogue gives assurance that the Institute of Technology, established at Boston by the State of Massachusetts, under the direction of Prof. Wm. B. Rogers, is in full and successful operation. The course of instruction as here presented is excellent. The corps of Professors is one of great scientific strength, it consisting of Wm. B. Rogers, President, besides Professor in Physics and Geology; John D. Runkle, Professor in Mathematics and Analytic Mechanics; Frank H. Storer, in General and Industrial Chemistry; Charles W. Eliot, in Analytical Chemistry and Metallurgy; Wm. P. Atkinson, in the English Language and Literature; John B. Henck, in Engineering; W. Watson, in Descriptive Geometry and Mechanical Engineering; Wm. R. Ware, in Architecture; James D. Hague, in Mining Engineering; F. Böcker, in Modern Languages.

11. *Cabinet of Minerals for sale.*—Dr. F. A. Genth, of Philadelphia offers for sale his fine cabinet of rocks and minerals, rich in both foreign and American specimens. It also includes a collection of fossils.

OBITUARY.

Dr. J. L. Riddell.—A committee, consisting of Rufus Staples and James S. Knapp, appointed by the New Orleans Academy of Sciences, on the 16th day of October, 1865, for the purpose of drafting some resolutions expressive of the sense of that body on the death of Prof. J. L. Riddell, together with a sketch of his life, made a report, the larger part of which we here republish.

Dr. John Leonard Riddell was born in Leyden, Mass., on the 20th day of February, 1807, and died in New Orleans on the 7th day of October, 1865. He was honorably descended from an ancient Scotch-Irish family. In the fall of the year 1807, he was taken by his parents to Preston, Chenango county, New York, where his boyhood was spent on his father's farm. He attended the Oxford Academy during portions of

the years 1826 and 1827, and afterward the Rensselaer School of Troy, N. Y., where he obtained the degree of A.B., and subsequently of A.M.

For several years, commencing in 1830, he gave lectures on chemistry, botany and geology in various places in the United States and in Canada. In 1835 he was appointed Adjunct Professor of Chemistry, and Prof. of Botany in the Cincinnati Medical College, where he received the degree of M.D.

In 1836 he was appointed Prof. of Chemistry in the Medical College of Louisiana, at New Orleans; at present the Medical Department of the University of Louisiana, now under the patronage of the State, which chair he retained, and filled with great credit till his death. In 1838 he was appointed "Melter and Refiner" in the Branch Mint, an office he held till 1849.

His contributions to science have been of a varied nature. In 1835 at Cincinnati, O., he published a catalogue of plants, entitled "*A Synopsis of the Flora of the Western States*," including 1800 different species, the earliest work of any importance specially devoted to the *Botany of the West*. Subsequently he published a catalogue of the plants of Louisana comprising some 2300 species. In the Western States, in Louisiana and in Texas, he was the discoverer of numerous new species of plants. His name is indelibly impressed on the science in the *genus* "Riddellia," named from him. He prepared the materials for the publication of a work on the botany of the Southern part of the United States, and leaves a very large and well arranged Herbarium.

In 1845, he published a "*Monograph of the Dollar*," with fac-simile impressions of between five and six hundred varieties of American and Mexican dollars and half dollars, both genuine and counterfeit, with the assays of each.

In 1836 his thesis on "*Miasm and Contagion*" was published in Cincinnati, and republished in Boston, in which he advocated the theory that "organized and living corpuscles of various kinds" were the agents of communication in contagious diseases; and in this he was one of the earliest to adopt that theory which seems now to be so rapidly gaining adherents.

For many years preceding his death, Doctor Riddell had directed great energy and attention to microscopic observations, examining minutely the animalculæ and algæ found in the swamp waters in the vicinity of New Orleans, of many of which he made drawings. His researches in this department of science, as well as botany, are well known and appreciated on both sides of the Atlantic. He invented a *Binocular Microscope* which gave the student in microscopy an advantage never before enjoyed.

As a lecturer on chemistry in the University of Louisiana, he was remarkable for perspicuity of style and diction. He enjoyed the highest esteem of the students, among whom he was extremely popular. Unlike many men of learning, his attainments formed no barrier to a personal approach by the unlettered; nor did they prevent him from kindly and constantly aiding others, nor from giving that attention to business affairs in which he was eminently successful, and by which he accumulated and left to his family a large and productive property.

In the New Orleans Academy of Sciences, of which he was one of the founders, he acted most efficiently as President nearly all of the time from its formation. Among the varied subjects under discussion, his uncommonly retentive memory, his accurate and general information, and his happy faculty of imparting knowledge enabled him to cast light on almost any subject under consideration. Their thanks are especially due to him for the preservation of the domicile of the Academy from occupation by the military, and its property from pillage and waste during the perilous times of civil war.

VII. MISCELLANEOUS BIBLIOGRAPHY.

1. *Photographic Mosaics;* edited by M. Carey Lea and Edward L. Wilson, Editor of Philadelphia Photographer. 144 pp. 12mo. Philadelphia, 1866 (Benerman & Wilson).—A valuable work for photographers, adepts as well as learners, consisting of selections from various recent works and memoirs on photography on numerous topics of practical value in the art.

2. *Smithsonian Report for* 1864.—The following are the contents of the Annual Report of the Smithsonian Institution, including its appendix for 1864.—Report of the Regents, including Report of the Secretary, Prof. Henry, etc., pages 1–114.—p. 125, Memoir of Delambre; Joseph Fourier.—p. 135, Essay on the Velocity of Light; M. Delaunay.—p. 166, Ozone and Antozone; Charles M. Wetherill, Ph.D., M.D.—178, Vegetation and the Atmosphere; J. Jamin.—p. 191, Extract of a Memoir on the Preservation of Copper and Iron in Salt Water; M. Becquerel.—p. 196, Preservation of Wood.—p. 206, Caoutchouc and Gutta Percha.—p. 221, The Products of the Combustion of Gun Cotton and Gunpowder under circumstances analogous to those which occur in practice; Lieut. von Karolyi.—p. 235, Description of Apparatus for testing the results of Perspiration and Respiration in the Physiological Institute at Munich; Prof. Max Pettenkofer.—p. 240, The Solar Eclipse of July 18, 1860; Dr. J. Lamont.—p. 261, Report on the Transactions of the Society of Physics and Natural History of Geneva, 1861; Rev. M. Duby, President.—p. 282, On the Crania Helvetica; Frederick Troyon.—p. 285, Experimental and Theoretical Researches on the Figures of Equilibrium of a liquid mass withdrawn from the action of Gravity, &c., Prof. J. Plateau.—p. 370, Artificial Shell-deposits in New Jersey; Charles Rau.—p. 375, The Intermixture of Races; George Gibbs.—p. 378, An account of the aboriginal inhabitants of the California Peninsula; Jacob Baegert.—p. 400, The first steps in the study of High Antiquity in Europe; A. Morlot.—p. 412, Scientific Expedition to Mexico. A Report addressed to the Emperor by the Minister of Public Instruction.—p. 416, A Journey to the Youcan, Russian America; W. W. Kirby.—p. 421, Exploration in Upper California in 1860 under the auspices of the Smithsonian Institution; John Feilner, U. S. A.—p. 431, Journal of an Exploration of Western Missouri in 1854, under the auspices of the Smithsonian Institution; P. R. Hoy, M.D.—p. 439, Tables of Weights and Measures.

3. *Aus Sahara und Atlas*, vier Briefe au J. Liebig von E. Desor. 72 pages 8vo, with several tables. Wiesbaden, 1865 (C. W. Kreidel).—The four letters here contained give an account of the interesting excur-

sion made by Mr. Desor in the region of the Sahara desert. We have already given some account of the explorations in volume xxxvii, at pages 146 and 445, 1864.

Astronomical and Meteorological observations made at the U. S. Naval Observatory during the year 1863. Captain J. M. Gilliss, U. S. N., Superintendent. 494 pp. 4to. Washington, 1865. Published by authority from the Hon. Secretary of the Navy.

The Cooling Globe, or the Mechanics of Geology; by C. F. Winslow, M.D. 64 pp. 8vo. Boston, 1865. (Walker, Wise & Co.)

Giornale di Scienze Naturali ed economiche publicato per cura del consiglio di Perfezionamento annesso al R. Istituto Tecnico di Palermo. Volume I, Fascic. i (96 pp.), ii (76 pp.), large 4to, with plates. 1865.

Proc. Acad. Nat. Sci. Philadelphia, No. 3, July and August, 1865.—Page 109, On New Fossils from the Marshall Group of Michigan and its supposed equivalents in other States, etc.; *A. Winchell.*—p. 134, Amphibamus grandiceps, a new Batrachian from the Coal Measures; *E. D. Cope.*—On the genus Taxocrinus of McCoy, with descriptions of new species; *Meek & Worthen.*—p. 143, New Crinoids from Illinois; *Meek & Worthen.*—p. 166, Note on the genus Gilbertsocrinus of Phillips; *F. B. Meek.*—p. 168, On a whale caught in the river Delaware; *E. D. Cope.*—p. 169, On some Conirostral Birds from Costa Rica; *J. Cassin.*—p. 172, New Polyzonidæ; *H. C. Wood, Jr.*—No. 4, September and October, 1865.—p. 173, A new genus of Vespertilionidæ; *H. Allen.*—p. 177, A new generic type of Sharks; *T. Gill.*—p. 178, Note on a species of hunch-backed Whale: *E. D. Cope.*—p. 184, Obs. on American fossils, with descriptions of two new species; *T. A. Conrad.*—p. 185, Contrib. to the Herpetology of tropical America: *E. D. Cope.*—p. 198, Contrib. to a knowledge of the Delphinidæ; *E. D. Cope.*—p. 204, Species of Galeruca and allied genera inhabiting N. America; *J. L. LeConte.*—p. 222, Monograph of the Anobiinæ of N. America; *J. L. LeConte.*

Transactions of the Amer. Phil. Soc. Philad. Vol. xiii. Part ii, 1865. Art. vii. On the Myriapoda of N. America; *H. C. Wood.*

Proceedings of the Amer. Phil. Soc. Philad., Vol. x, No. 74. 1865. Page 151, On Magnetic Polarity; *P. E. Chase.*—p. 170, Naturalization of exotic plants; *T. C. Porter.*—p. 171, Obituary of Dr. C. W. Short; *Gross.*—p. 187, Record of Oil-well borings; *J. P. Lesley.*

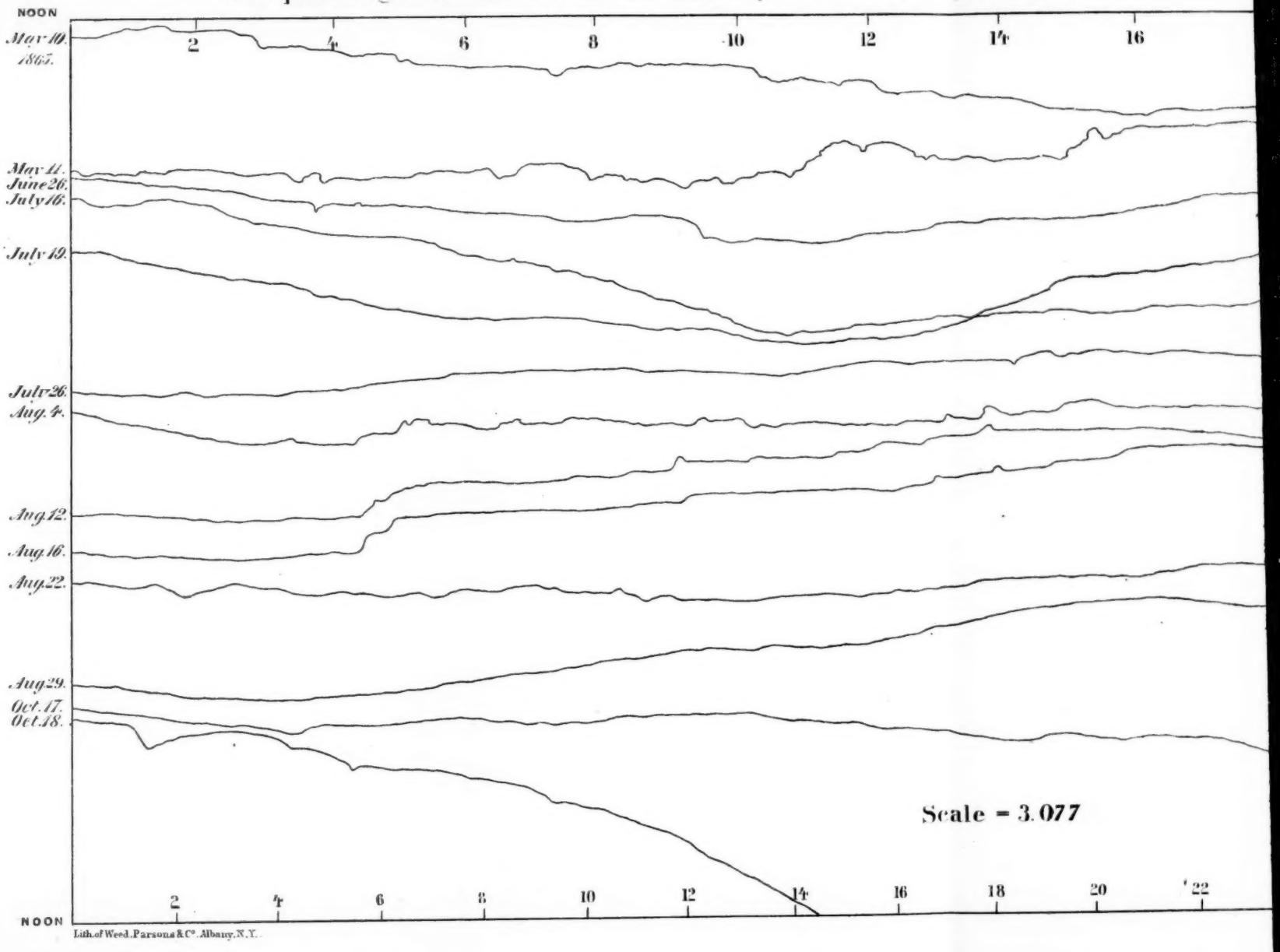
Proceedings Entomolog. Soc., Philadelphia, Vol. v, No. 1. July—Sept., 1865. Page 1, Revision of the hitherto known species of the genus Chionobas in N. America; *S. H. Scudder.*—p. 28, New species of Pselaphidæ; *E. Brendel.*—p. 33, Note on Cuban Sphingidæ; *A. R. Grote.*—p. 85, Monograph of the Philanthidæ of N. A.; *E. T. Cresson.*—p. 133, N. A. Micro-Lepidoptera; *B. Clemens.*—p. 148, A new species of Limenitis; *W. H. Edwards.*

Proceedings Bost. Soc. Nat. Hist., Vol. x. Jan. 1864.—page 1, Death of Dr. Wheatland.—p. 2, Obituary notice of F. Alger; *C. T. Jackson.*—p. 6, On Wardian cases; *W. T. Brigham.*—p. 11, Habits and geographical distrib. of the common lobster; *N. E. Atwood.*—p. 13, Deep sea Atlantic soundings; *C. Stodder.*—p. 14, Habits of a species of Pteropod; *A. Agassiz.*

Proceedings of the Essex Institute, Vol. iv, No. vi. April, May, June, 1865.—p. 161, Conclusion of Notes on the Duck Hawk; *J. A. Allen.*—p. 162, A classification of Mollusca, based on the principle of Cephalization, with a plate; *E. S. Morse.*

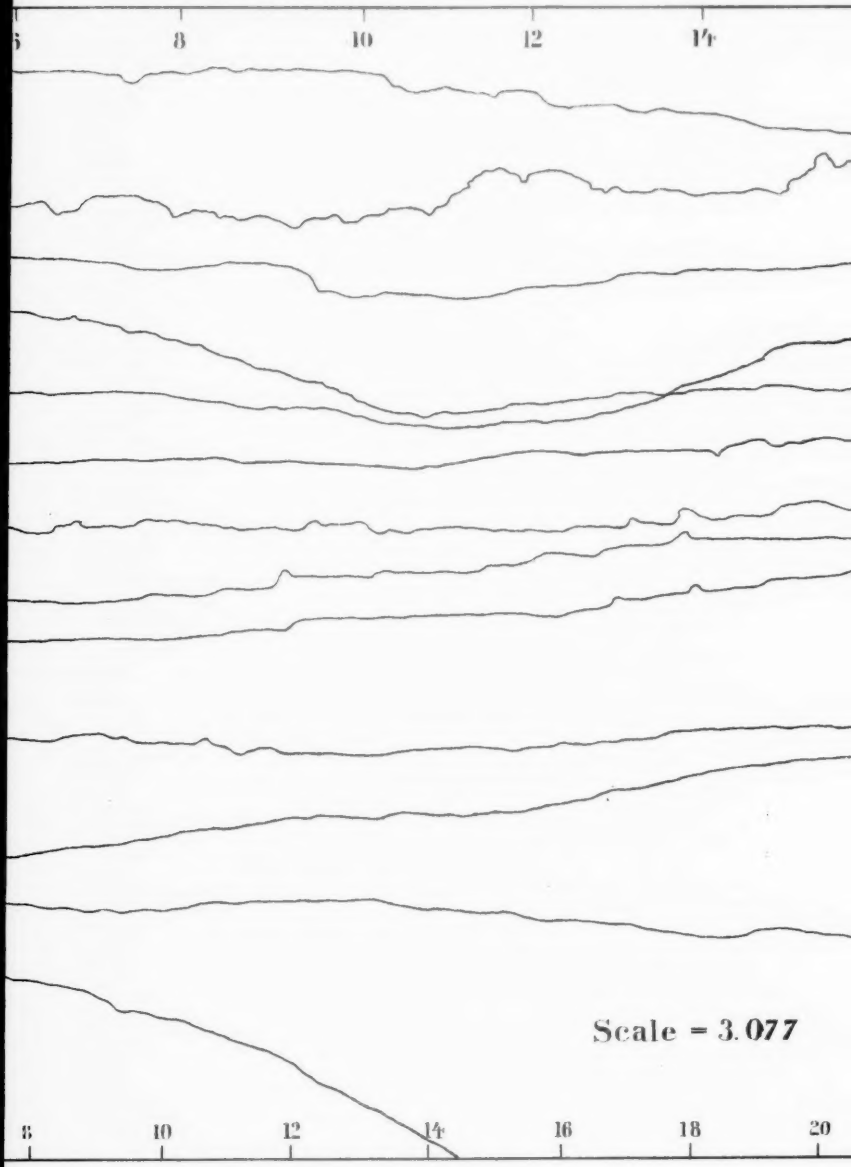
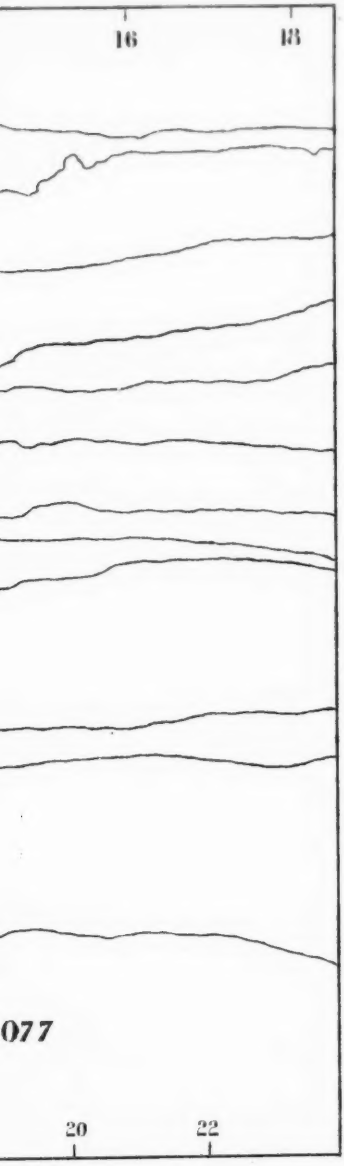
Proceedings and Transactions of the Nova Scotian Institute of Natural Science of Halifax, Nova Scotia, Vol. ii. Part iii. 1864-5.—p. 8, Mammalia of N. Scotia; *J. B. Gilpin.*—p. 15, Provincial acclimatization; *C. Hardy*—p. 30, Calluna vulgaris on C. Breton Id.; *G. Lawson.*—p. 35, on Lemania variegata; *id.*—p. 38, Land-birds of N. S.; *A. Downs.*—p. 51, Obs. on the sea-birds of St. Margaret's Bay, N. S.; *J. Ambrose.*—p. 70, Production of lakes by ice-action; *T. Belt.*—p. 71, On brine-springs of N. S.; *H. How.*—p. 80, Enquiry into the Antiquity of Man; *W. Gossip.*—p. 102, Weather at Halifax, N. S., during 1864; *Myers.*—p. 107, On the Gaspereaux; *J. B. Gilpin.*—p. 114, Reptilia of N. S.; *J. M. Jones.*—p. 128, On the economic mineralogy of N. S. Part ii, Ores of Manganese and their uses; *H. How.*—p. 139, Meteorological register; *Myers.*—p. 140, Currents on the N. E. Coast of America; *A. Milne.*—p. 142, Contorted quartz at Laidlaw's "Diggins," Waverly.—p. 145, Mummy of the Great Auk from Funk Island.

Specimen of barometric curves as recorded by the Automatic registering and printing Barometer, at the Dudley Observatory, Albany, N.Y.



Lith. of Weed, Parsons & Co. Albany, N.Y.

ric curves as recorded by the Automatic regist
ometer, at the Dudley Observatory, Albany, N



egistering
any, N.Y.